

ZOOLOGICAL RESULTS

BASED ON MATERIAL FROM

NEW BRITAIN, NEW GUINEA, LOYALTY
ISLANDS AND ELSEWHERE,

COLLECTED

DURING THE YEARS 1895, 1896 AND 1897,

BY

ARTHUR WILLEY, D.Sc. LOND., HON. M.A. CANTAB.

LECTURER ON BIOLOGY IN GUY'S HOSPITAL, LONDON.

PART IV.

(MAY, 1900.)

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¹ I am desirous to state that this article was written in November 1898 and received by me from the author upwards of twelve months ago. A. W.

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ON THE ANATOMY OF A SUPPOSED NEW SPECIES OF COENOPSAMMIA FROM LIFU.

By J. STANLEY GARDINER, M.A.,
Fellow of Gonville and Caius College, Cambridge.

With Plate XXXIV.

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PREFACE.

Amongst the material very generously handed over to me by Dr Willey for examination were nine colonies, with from two to twelve polyps, of a species of *Coenopsammia*, which I believe to be new, and for which I propose the specific name of *C. willeyi*. All were obtained at Sandal Bay, Lifu, from the surfaces of reef-patches on the under-side of coral masses in company with *Distichopora* and *Stylaster*. The colour of the living colonies was bright red, with orange mouth-discs or peristomes.

All were preserved by dropping into 90 per cent. alcohol—sometimes with addition of formalin—which seems in most cases to have penetrated rapidly, so that they are well preserved for histological purposes.

The genus *Coenopsammia* was first defined by Milne Edwards and Haime (6), who described nine species and placed the genus in the family Eupsammidae. The classification of these authors was in the main retained by Martin Duncan (5), who grouped in a somewhat arbitrary manner their several families into various alliances, and added the definitions of the numerous new genera described since the publication of the *Histoire des Coralliaires* (6).

The genus *Coenopsammia* is one of the simplest members of the family Eupsammidae, and the species here described has no zooxanthellae in its endoderm and must hence feed entirely by means of the food taken in through its stomodoeum. Furthermore it produces buds from the basal edge of the polyp as do the most primitive colonial Actiniae, and might therefore reasonably be expected to retain much of the structure of the Hexactinian polyps from which all the Madreporaria seem primitively to have been derived.

For the so-called mesogloea or jelly I prefer to use the term structureless membrane or basement membrane, as the layer appears to me to be of the same nature as basement membranes in general.

SECTION I.

GENERAL ANATOMY OF THE SKELETON AND SPECIFIC DESCRIPTION. (Pl. XXXIV., Figs. 1—3, and text-figures, I. II.)

The corallum¹ is devoid of any epitheca, the whole except the attached base being covered by the polyps. It occurs in its younger stages in the form of a single corallite, which is gradually built up by the polyp, increasing both in diameter and height. At the same time the theca is thickened near the base of the corallite by deposit from the extrathecal portions of the polyp; and irregularly arranged intrathecal platforms, or pseudotabulae, are formed across the calice.

Budding takes place near the base of the parent corallite, two, three or more daughter corallites being constantly found of about the same size and age. The buds at first project almost at right angles from the sides of the original corallite, but by a more rapid growth of their outer or distal sides gradually turn upwards, yet always at some slight angle to the parent corallite (Fig. 2). The greatest diameter of one such corallite was 7.5 mm., and of its three buds from 3.5 to 5.5 mm. The original corallite was 14 mm. high, and the calices of the budded corallites formed a ring about 5 mm. below the margin of its theca.

¹ For definition of terms relating to the skeleton see Martin Duncan (5).

With the production of buds the base of the colony broadens. The parent and daughter corallites continue to increase in height and size, daughter polyps being again formed on their outer sides by budding from their free basal edge. The final result is an incrusting mass with a number of corallites standing up separately upon it, the oldest being typically in the centre (Fig. 1).

As the corallites are built up, skeleton of a loose, porous nature—peritheca¹—is deposited between them by the extrathecal portions of their polyps. The different corallites of a colony are hence only free for a limited height, the highest free portion of any corallite in the collection being 12 mm., and the greatest diameter of the largest corallite 9 mm.

Hence, if growth proceeds regularly, a low convex mass is formed, the corallites gradually decreasing in height and diameter from the centre outwards. The colonies in the collection have this general form, but are all very small—largest 5.5 cm. across (Fig. 1)—and rather irregular, being overgrown in places by foraminifera, sponges, and other organisms. To the struggle between these and the polyps may be directly ascribed in many places the variation in height of the corallites above the colony. The mode of growth however of the species can be distinguished in all.

The corallites have on the outside an appearance of longitudinal striae, due to the presence of low, rough, subequal costae, which correspond in number and position to primary, secondary, tertiary, and quaternary septa. Many of the costae are continuous from the parent to the daughter corallites in the young stage, but where much peritheca has been formed there is a distinct narrow valley between the corallites, from which the costae diverge.

The theca is thin, and for a few millimetres below its upper edge very freely perforated in lines between the costae (Fig. 1.). It does not appear to be a true theca, formed in the first place by the basal ectoderm as a ring on the basal plate, joining the septa, but rather a pseudotheca, formed by the fusion of thickenings of the septal sides.

The calice is slightly oval in shape, the two diameters being in the proportion to one another of nine to eight. Within it septa of three cycles are present, of which the primaries and secondaries fuse with the columella (Fig. 3). The primary septa generally project from the edge of the calice almost horizontally inwards for about a quarter of its diameter—they often in the younger corallites rise slightly above the level of the theca—ending by the axial fossa with almost smooth vertical edges. The two primary septa, which lie between the directive mesenteries at each end of the longer diameter of the calice—hence termed directive septa—do not project for more than about one-seventh the diameter, so that the axial fossa is very distinctly oval².

The secondary septa project horizontally from the upper edge of the calice for about one-twelfth its diameter, ending then with almost vertical edges, but abruptly broadening to join the columella. The tertiary septa are small and inconspicuous, and the quaternary are low ridges, only seen in ground down surfaces or sections towards the base of the calice.

¹ For definition of this term see p. 361.

² These proportions are not clearly shown in the figure, which has been somewhat diagrammatically drawn by the artist.

The septa naturally decrease in thickness from the primaries to the tertiaries. All are relatively thin and little perforated, with almost smooth edges and sides covered with low, blunt, somewhat distant granules, not arranged in any determinate manner. Synapticula are absent.

The columella closes in the axial fossa below, and owing to the narrow directive septa, added to the slightly elongate shape of the calice, is very distinctly oval. It varies in depth, in the larger corallites being situated from 4 to 5 mm. below the edge of the calice. In the youngest separate corallite, that I have examined, there appeared to be a true columella, arising from a basal plate, but in the older calices it has a spongy appearance, and seems to have been formed principally by the anastomosis of a large number of trabeculae from the septal edges.

I have not attempted to examine the minute anatomy of the corallum in any detail. The skeleton in all the specimens is everywhere much bored into by algal filaments, which although found principally in the deeper lying parts extend in places to within .2 mm. of its surface.

SECTION II.

GENERAL ANATOMY OF THE POLYPS.

Composition of the Colony. The corallum, as mentioned before, is everywhere, except over its attached base, covered by the polyps. The latter may be regarded each as an independent individual capable of leading an independent existence. All the polyps however are connected together by the coenosarc, which consists of a number of canals separated from one another by a double layer of endoderm with the structureless membrane between. These canals run from polyp to polyp—branching perhaps at the bases of the projecting corallites—and serve to put the gastrovascular cavities of the different polyps in free communication with one another.

A similar arrangement is found in *Pocillopora* and all corals, so far as I am aware, which have a well-developed peritheca, save that in some genera, as pointed out by Fowler (10), the canals have been pushed apart from one another and the external wall, consisting now of a double layer of ectoderm with the structureless membrane between, lies directly on the corallum. In imperforate *Madreporaria* the coenosarc canals may be said to commence from the edge of the calice, while in perforate forms, especially in such forms with partially free corallites as *Coenopsammia*, no such sharp line of distinction can be drawn, since the intracalicular portions of the

coelentera at frequent intervals communicate with the coenosarcal canals by ramifying canals through the theca.

The coenosarcal canals in fact are simply extrathecal portions of the coelentera of the different polyps, which serve to connect their intrathecal or gastrovascular portions.

Peritheca and coenosarc. The corallum except over the base of attachment is everywhere covered by the calicoblast layer of ectoderm. This is constantly depositing skeleton over all parts more or less rapidly. Skeleton so deposited has been termed by Martin Duncan (5), when it occurs outside the theca and between the costae, the "exotheca," and, when it serves to fill up the valleys between the free portions of the corallites, the "coenenchyma." Indeed, when the deposit of corallum outside the corallites was small, Martin Duncan called it "exotheca," but, if considerable, "coenenchyma."

In the asexual method of reproduction, which forms the colony, whether by fission or bud formation, there is at first no coenenchyma between the two individuals, or between the bud and its parent corallite. In individual specimens of any species the coenenchyma varies enormously with the rate and form of growth of the colony; it hence seems to me improbable that its relative abundance alone can be in any genus a specific distinction. There is no sharp line of separation nor of structure between the "exotheca" and the "coenenchyma" in *Coenopsammia*, nor indeed in most Madreporaria, the latter as it is built up being necessarily fused with the former. In *Galaxea* however the distinction is well marked, the "coenenchyma" having a porous and the "exotheca" a compact structure.

It hence appears to me advisable that the term "coenenchyma," if retained in the Madreporaria, should be applied either to the structure usually so-called in *Galaxea* or to all parts of the corallum outside the theca. The term is of such wide application that it would only increase the confusion, which already prevails, to restrict it in such a way. Either use of the term too is directly opposed to its well-established use in the rest of the Anthozoa. I accordingly propose to use the term **peritheca**, which was employed in the first place by Milne Edwards and Haime for the so-called "coenenchyma" of *Galaxea*. *The peritheca is that part of the corallum of colonial Madreporaria, which is deposited outside and subsequently to the theca. The coenosarc is that part of the polyps in a colony which lies outside but not above (i.e. in expanded state) the thecae of the several corallites.* The "Randplatte" of Heider and von Koch, the "edge-zone" of Miss Ogilvie, is then that part of the coenosarc which lies over the free portions of the corallites. The above use of the term coenosarc is more in accordance with its physiological meaning in the Alcyonaria and Hydrozoa.

The expanded polyp. As all the polyps of the specimens, entrusted to me by Dr Willey, are completely retracted, it is impossible to speak definitely of the conditions found in the living polyps. However, from the appearance of the contracted muscles and the accordingly much bent mesenteries, I am led to believe that the polyps expand themselves to a height of at least 4 mm. above the top of the theca. The tentacles then form three circles close to one another round the peristome, or mouth-disc, the outer with twelve, and the two inner each with six tentacles, the bases of the outer and the two inner circles alternating with one another.

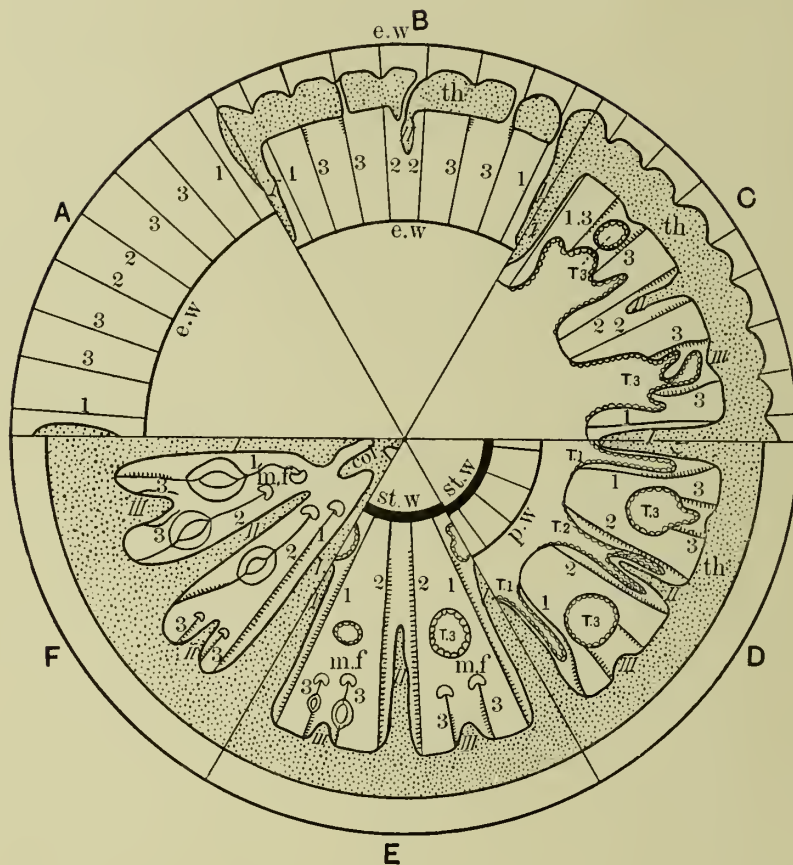


FIGURE I. Diagrammatical transverse section through a single completely retracted polyp in six different planes shown approximately in Fig. II.

The section is that of a single lateral sextant (or system)—without directive mesenteries—of the same polyp traced downwards in a series of transverse sections.

The sextant is taken from the middle of one primary septum to the middle of the next. (The position of the sections will be readily understood by reference to Fig. II., but the polyp, from which this figure was made, was not quite in the same state of retraction.)

The corallum is dotted and covered everywhere by the calicoblastic ectoderm, structureless membrane or lamella, and endoderm. *th.* Theca. I, II and III. Primary, secondary and tertiary septa. *col.* Columella (only seen in F). *e.w.* Body-wall (consisting of ectoderm, structureless membrane and endoderm) external to the mouth-disc or peristome, limited by the bases of the tentacles. *p.w.* Body-wall of mouth-disc or peristome. *st.w.* Body-wall of the stomodoeum, much thickened owing to the very thick ectodermic epithelium. *T.1*, *T.2*, and *T.3* Completely retracted primary, secondary and tertiary tentacles covered with batteries

of nematocysts. 1, 2 and 3, Primary, secondary and tertiary mesenteries, consisting of two layers of endoderm with the structureless membrane between. The retractor muscles are indicated as fine lines at right angles to the mesenteries. *m.f.* mesenterial filaments.

SECTIONS.

A. Above the theca. The primary septa are represented although they do not, except in young corallites, project above the theca.

B. About half-way between the top of the stomodoeum and the top of the polyp. The theca is complete and divides the coelenteron into extra- and intrathecal portions, connected together by numerous perforating canals, commonly running as represented. The extrathecal portions of the coelenteron are divided into canals, which correspond in number and position to the spaces between the mesenteries. The costae and secondary septum are well marked and the tertiary retractor muscles have appeared.

C. Through the mouths of the retracted tertiary tentacles, which lie externally to those of lower orders. The retractor muscles of the secondary mesenteries have appeared and the tertiary septa are indicated. (The perforating canals of the corallum and the perithecium are not represented in this and subsequent sections.)

D. Through the mouths of the retracted primary and secondary tentacles. The polyp is cut across in two places owing to the somewhat raised lip round the stomodoeum.

E. Through the lower half of the stomodoeum. The lower free ends of the retracted primary and tertiary tentacles are well marked. The tertiary mesenteries are free with distinct filaments; in the left pair ova are represented, covered by the much thickened nutritive endoderm.

F. Towards the base of the polyp. The right half of the section is rather higher than the left. In it the tertiary mesenteries are much narrower with smaller filaments and without ova, which have now appeared in the secondary mesenteries. In the left half the tertiary mesenteries have lost their filaments and muscles and will shortly disappear; the secondary mesenteries are narrower and have lost their muscles, while in the primary mesenteries ova have appeared.

The contracted polyp. In the completely contracted condition the opening of the stomodoeum is situated about 1.5 mm. above the top of the columella. The peripheral part of the mouth-disc is drawn inwards and downwards, causing a marked depression round the stomodoeal opening. This condition is brought about by the presence of a strong circular sphincter muscle—*Röttken's muscle* of the Actinaria—(Fig. II. *m.s.*) together with that of strong longitudinal muscles on the mesenteries, spreading out under the oral disc and within the tentacles. The presence of a circular muscle in the Madreporaria was first suggested by Moseley (21) in *Sphenotrochus* and subsequently described by Fowler in the same genus (9) and also in *Duncania* (11). But, whereas in these genera the sphincter opening leads into a cavity in which the tentacles lie, the condition differs in *Coenopsammia* owing to the complete introversion of the tentacles in a more irregular manner but similar to that of *Seriatopora* (9). In fact

round the stomodoeal opening is a prominent ridge, in the depression round which lie the openings of the introverted tentacles (Figs. I. and II.).

Coenosarcal canals and mode of budding. The mesenteries are 48 in number and have a determinable position in respect to the 24 septa. There are 48 intermesenterial spaces, 24 *entocoelic* between mesenteries of the same pair, into which the septa project, and 24 *exocoelic* spaces between mesenteries of neighbouring pairs¹. From each intermesenterial space is given off a coenosarcal canal passing outside the theca. The dividing walls of these are continuous with the mesenteries over the theca, and indeed may be regarded as their peripheral ends or extrathecal portions (Figs. I. and II.). The coenosarcal canals end blindly at the free edges of the colony, but in the central parts they put each intermesenterial space of each several polyp into communication with at least one such space in a neighbouring polyp.

Budding takes place from the blind ends of the coenosarcal canals at the basal margin of the single polyp or colony. A number of the coenosarcal canals fuse together and a mouth breaks through. The intermesenterial spaces of the daughter polyp on the inner side, *i.e.* towards the parent polyp, are each formed directly from a single coenosarcal canal, while those at the sides are formed by the branching of these canals. The mesenteries are formed from the dividing walls of the coenosarcal canals, *i.e.* from the extrathecal portions of the mesenteries of the parent polyp. The young corallite appears to be very rapidly formed, and has from the first a diameter of 2.5 mm.²

The intermesenterial spaces, besides being in communication with the coenosarcal canals over the theca, have also connecting canals through the theca. The dividing walls of the coenosarcal canals outside the free portions of the corallites are attached to the skeleton between the costae, which project into their lumina. The mesenteries on the other hand have their broad bases attached to the septa close to their fusion into the theca, and hence somewhat facing one another. The connecting canals near the top of the theca from the exocoels run straight through the theca near the base of one of the bounding mesenteries and open into their corresponding coenosarcal canals (Fig. I., B). In the entocoels the arrangement is similar in the same position, but the connecting canals often arise at a considerable distance up the sides of the septa and perhaps run diagonally through them. *This arrangement of connecting canals near the top of the theca, joining the intermesenterial spaces with their corresponding coenosarcal canals alone, strongly supports the view that in this species the theca is formed simply by the fusion of thickenings on the sides of the septa.* Lower down in the polyps instead of separate connecting canals, a system of ramifying and anastomosing canals is found, similar to that described by Fowler for *Rhodopsammia* (7), but not so complicated, owing probably to the more delicate corallum.

¹ There would thus be between neighbouring primary septa, in each system 8 mesenteries, 2 primary, 2 secondary, and 4 tertiary. In one polyp however in one system there were 10 mesenteries owing to an addition of 2 tertiary, but the next system had only 6 mesenteries, 2 tertiary being absent.

² In the various colonies in the collection I have only found one bud without a corallite, and in this the preservation was not sufficiently good for me to follow out the process in any detail. I have traced however the connections of two buds, each of about 3 mm. in diameter, with the parent polyp.

Tentacles. The tentacles are all entocoelic, and their three orders correspond to the orders of septa, the tertiaries being situated most externally on the mouth-disc. The introverted tertiary tentacles form deep pockets in the entocoeles of the

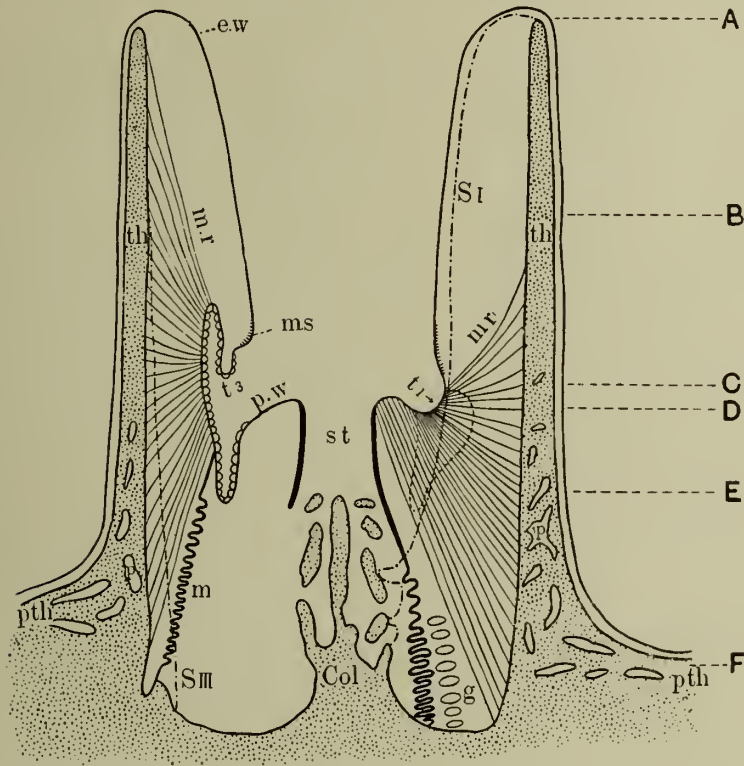


FIGURE II. Diagrammatical longitudinal section of a polyp, the left half passing through the opening of a tertiary tentacle and exposing the face of a tertiary mesentery, and the right half passing to one side of a primary mesentery exposing it likewise.

A—F. Sections shown in Fig. I.

th. Theca. *S. I.* and *S. III.* Primary and tertiary septa. *col.* Columella. *pth.* Peritheca. *p.* Perforating canals of the theca. *e. w.* External body-wall. *g.* Ova. *p. w.* Body-wall of mouth-disc. *st.* Stomodoeum. *T. 1* and *T. 3.* Primary and tertiary tentacles retracted. *m.* Mesenterial filaments. *m. r.* Retractor muscle. *m. s.* Circular sphincter muscle.

Left Half. The tertiary mesentery does not extend beyond the tertiary tentacle. Its muscles are well marked and attached nearly along its whole length to the theca, arising from the wall of the tentacle. Along the free edge a much convoluted filament is present except at its upper and lower ends. The ridge of corallum, represented at its lower edge, is not generally marked, and the mesentery does not reach the base of the polyp. The outline of a tertiary septum (*S. III*) is shown.

Right Half. The lip round the stomodoeum is well marked with a circular depression around, having the opening of a primary tentacle (*T. 1*), the position of which is shown

by a broken line. The outline of a primary septum (*S. I*) is also shown, fusing with the columella below. The retractor muscles arise from the whole of the mouth-disc, but are only attached to the lower two-thirds of the theca. The free edge of the mesentery is everywhere covered by a mesenterial filament, which is directly continuous with the stomodoeal epithelium above.

tertiary mesenteries both above and below their open mouths (Fig. I. C and Fig. II.). Shorter pockets are found too, especially in sections where the open mouth is cut through, projecting into the exocoeles outside the tertiary entocoele. In fact the tertiary mesenteries would appear to continue for some distance into the extended tertiary tentacles.

The introversion of the secondary and primary tentacles gives rise to deep somewhat irregular invaginations—extending only below their open mouths—in the entocoeles over their corresponding septa (Fig. I. D, and Fig. II.). The invaginated portions are crescent-shaped in transverse sections owing to the projecting septa, and have no side diverticula into the exocoeles. The mesenteries are attached, one at each side of the bases of these tentacles, and cannot extend into them in any way, when they are expanded. The tentacles appear as if they decrease considerably in length from the tertiaries to the primaries.

All the tentacles are covered with round, knobbed batteries of nematocysts, which gradually decrease in size from their tips. At their bases these batteries are very small, and pass almost imperceptibly—especially on the tertiary tentacles—into the general ectoderm.

Retractor muscles. The great longitudinal retractor muscles of the mesenteries have the regular arrangement, typical of the Hexactiniae, *i.e.* on the sides facing one another on all the pairs except the directives. Their course may be best seen by reference to Figs. I. and II. The fibres of the tertiary mesenteries arise from the tentacles alone, while those of the primaries and secondaries arise from the whole of the mouth-disc. They then run on all the mesenteries diagonally across to end near their attachments to the corallum. The lower part of all the mesenteries is free from muscular fibres.

On the faces of the mesenteries, opposite to the great retractor muscles, there are a few isolated longitudinal muscles with a similar course. They are rather more numerous on the directive mesenteries, the great retractor bands of which are not as large as those of the other primary mesenteries. There do not appear to be any definite protractor or transverse muscles. The circular sphincter muscle—Röttken's muscle—is a broad, diffuse band situated immediately below and outside—morphologically speaking—the tertiary tentacles (Fig. II.).

Stomodoeum. The stomodoeum is about 1 mm. in length in the contracted polyp. Its mouth is an elongate or oval slit, lying in the long axis of the directive septa, without any trace of gonidial grooves at its ends. Below the mouth its lumen is very irregular, being often drawn out into deep pockets between the septa.

Mesenteries. The tertiary mesenteries are attached to the mouth-disc in the tentacles, but do not reach to the aboral or basal body wall. Their free edges, except

immediately at the top and bottom, end in much convoluted filaments. The primary and secondary mesenteries are attached to the stomodoeum, with which their filaments are continuous, and also reach to the basal wall of the polyp. All the mesenteries decrease in breadth with the decrease of the muscular bands, and indeed the tertiary mesenteries are lost with their disappearance (Figs. I. and II.). The filaments of the primary and secondary mesenteries run straight into the polyp below the stomodoeum for 1—1.5 mm. before the convolutions commence. The filaments are attached to the mesenteries for their whole length, and are without free portions (acontia) at their lower ends.

Generative organs. All the polyps, which I have examined by sections—eleven from six colonies—are female, and have no trace of any male generative organs. The ova in each mesentery, in which they are found, are arranged in a row in the structureless membrane between the convoluted mesenterial filament and the great retractor muscle (Fig. II.). In the youngest polyps examined (3 mm. across the calice) ova only occurred on the primary mesenteries, but in all the others—eight—had passed into the secondary mesenteries as well. In two large polyps, the one cut into longitudinal and the other into transverse sections, I also found small ova in the structureless membrane of some of the tertiary mesenteries. The ova do not seem to pass into the directive mesenteries as soon as the other primaries, perhaps on account of their being less broad through the elongation of the stomodoeum.

The ova are presumably formed as in the Hexactiniae from the endoderm, and wander into the structureless membrane (13 and 14). They here wander into the structureless membrane of any mesentery, provided that it is of sufficient breadth. I have also found a similar arrangement in *Prionastraea abdita*, and it seems very doubtful, whether the order of the mesentery, in which the generative organs are found, is of any importance.

SECTION III.

MINUTE ANATOMY.

Ectoderm. (Figs. 4 and 5.) The *external* ectoderm, *i.e.* of the general surface of the colonies outside the tentacles, is very well preserved, and seldom or never detached from the underlying structureless membrane. It is about .03 mm. in thickness, and has a very uniform and much vacuolated appearance. Cell outlines can seldom be distinguished, but it appears to be an epithelium of a columnar facies with a distinct layer of nuclei in the centre. The latter are small, oval, with a few granules and deep staining nuclear membranes. A few smaller, round nuclei, staining homogeneously, are also found, and perhaps belong to sense cells (Fig. 5). Small nematocysts are scattered about, but occur principally opposite to the attachments of the dividing walls of the coenosarcal canals, where the epithelium is rather thicker. They vary up to about .02 mm. in length, and generally have the same structure as the nematocysts of the tentacles. A few, however, are exactly similar, except in size, to the nematocysts found on the mesenterial filaments.

Gland cells of two kinds are found, mucous and granular. The former stain brown in Heidenhain's iron haematoxylin and eosin, and are fairly numerous all over the coenosarc, yet gradually decreasing in number from the bases of the tentacles downwards. The granular gland cells correspond to the "körnige Drüsenzellen," described by the Hertwigs in Actiniae (14). Their granules are very small, and stain black in iron haematoxylin and eosin (Fig. 4). In shape some are narrow and very elongate, while others are almost round or sack-like. In one young polyp (about 4 mm. across the calice) they are very numerous for about 3 mm. below the tentacles, but over the coenosarc between the free portions of the polyps very scarce. In older polyps they are commonly found only at the bases of the tentacles.

A few oval nuclei occur immediately above the structureless membrane, but there is no well-marked punctate nervous layer except near the bases of the tentacles. Muscular processes of the cells and distinct muscular fibres are completely absent. The surface of the layer is sometimes covered with mucus, but generally it is sharply defined, and there is no appearance of the ciliation described by the Hertwigs in the Actiniae.

The *ectoderm of the mouth-disc* is very similar to the external ectoderm, but rather thicker—about .04 mm.—and with a distinct finely punctate layer of nerve fibrils, immediately over the structureless membrane. Some of the cells too have distinct basal muscular processes. Mucous gland cells are numerous, especially near the mouth of the stomodoeum, but granular gland cells are absent. The nematocysts are more numerous than in the external ectoderm and of the same two kinds, the tentacular towards the exterior and the mesenterial around the stomodoeal opening.

The *ectoderm of the tentacles* takes the form of batteries of nematocysts (Fig. 6). Each battery is packed in the centre with nematocysts, close to the basal ends of which are a number of rod-shaped, or oval nuclei. Below these and towards the sides of the tentacles the nuclei are round or very slightly oval. All stain homogeneously with iron haematoxylin, the oval, granular nuclei of the external ectoderm being very rare. Under the centre of the battery on the structureless membrane is a thick, finely granular mass with a few supporting fibrils, a great concentration of the nervous layer (*n.l.* Fig. 6). A few mucous cells occur towards the sides of the batteries, but granular gland cells are absent. The muscular processes of the cells form a well-marked, thin, deeply staining layer on the structureless membrane. They appear to run mainly in a longitudinal direction in respect to the expanded tentacles, and arise principally from the cells around the central mass of nematocysts. In the contracted condition the central part of the battery is sometimes slightly depressed, but generally the nematocyst mass is much pushed out owing to the contractions of these muscles.

Tentacular nematocysts (Figs. 7–10). The tentacular nematocysts, when ripe, with the thread well formed (Fig. 7) are very uniform in size, about .027 mm. in length by .003 mm. in diameter. The thread is spirally coiled round a central homogeneous mass of protoplasm, and causes the external membrane of the nematocyst to project over it. The number of coils varies from 20 to 30, but commonly there are about 24. In most nematocysts the terminations of the thread cannot be distinguished, but in some the thread may be seen to end at the base of the capsule in a very finely granular mass of protoplasm, while at the opposite end it runs inwards

and slightly backwards at first, and then straight to the somewhat pointed and slightly projecting free end of the nematocyst. Generally the basal end of the nematocyst lies in a finely granular mass of protoplasm with a nucleus either oval or rod-shaped. Usually a filament, comparable to the granular peduncle described by Lendenfeld in *Hydra* (19), can be distinguished running down to the nervous layer; the structureless peduncle of Hamann (12) cannot be seen, but numerous processes of the structureless membrane pass everywhere into the ectoderm.

Although I have very carefully examined the nematocysts in the tentacles of seven polyps, I have failed to find any of a structure differing from the above. The whole nematocyst is thrown out when the thread is extruded, and in thick sections I have been able to follow every stage of the process. The end of the thread is ejected first and then turn after turn of the spiral follows (Fig. 8). The thread itself under ocular 4 and $\frac{1}{12}$ oil immersion, appears for its whole length to be absolutely homogeneous and structureless.

I have considered it necessary to describe the structure and the appearances on extrusion in some detail, as Möbius (20) appears to have confused nematocysts similar to these in the tentacles of *Caryophyllia* with those found on the mesenterial filaments of the same form. He appears indeed to have considered them to be young stages in the development of the mesenterial nematocysts. Bourne (4) too, following Möbius, gave a figure of a similar nematocyst, apparently not quite ripe, as a developing nematocyst of the mesenterial form.

Although I have not been able to follow every stage in the process of formation of these nematocysts, yet it seems to be as follows. In the place of the ejected nematocyst appears a homogeneous mass of protoplasm, extending almost from the surface of the ectoderm to the structureless membrane, and having near its base a nucleus. The central part of this acquires a definite membrane and subsequently forms the nematocyst. No nucleus can in any stage be distinguished within this membrane, but the basal nucleus is nearly always well marked. Its protoplasm next becomes very finely granular (Fig. 9), and the fine granules then fuse together and arrange themselves in definite spiral lines close under the external membrane (Fig. 10). The young nematocyst is now about one and a half times as long and thick as when ripe. Lastly the granules fuse, forming the thread, and the external membrane still further contracts. The thread seems to be tightly coiled up under a very elastic external membrane and to be extruded mainly by its own elasticity. Even in preserved specimens, when the ripe nematocysts are broken or cut across, three or four coils of the thread will uncurl. The thread indeed resembles both in its development and appearance the elastic fibres in the connective tissue of Vertebrates.

Stomodoeum (Fig. 11). The ectoderm of the stomodoeum is rather thicker than that of the mouth-disc, which gradually merges into it. It is composed of an elongated columnar epithelium with crowded, rod-shaped nuclei, all staining homogeneously. Over the structureless membrane is a thick, finely granular nervous layer—not distinctly seen in the figure—with a few round nuclei and supporting fibres. A few nematocysts like those of the mesenterial filaments but much smaller are found; tentacular nematocysts are extremely rare.

Mucous cells are scarce, but the epithelium is in places crowded with goblet-like vacuoles with numerous interstitial nuclei towards the exterior (Fig. 11). They are commonly much swollen with some apparently fluid unstainable secretion, and no nuclei especially belonging to them are visible. These secreting vacuoles are found principally opposite to the attachments of the primary and secondary mesenteries. Indeed in some polyps they form well marked lines over these mesenteries, extending up almost to the mouth of the stomodoeum. In one specimen, in which a Copepod is lying partially in the stomodoeum and partially in the coelenteron, the vacuoles are much smaller and generally appear to have discharged their secretion.

Mesenterial filaments (Figs. 12 and 13). The mesenterial filaments of the primary and secondary mesenteries are the direct continuations of the lower edge of the stomodoeum and have a very similar structure to that described by Bourne (3) and Fowler (8) for other Madreporaria. They are of a somewhat crescentic shape in transverse sections (Fig. 12) and their epithelium is sharply marked off from that of the mesentery below them. The structureless membrane of the mesenteries ends in a T-shaped swelling with numerous fibres passing off into the filament from its ends.

The central part of the filament is crowded with goblet vacuoles and is the "Drüsenstreifen" of the Hertwigs (14) and other German authors. This gradually passes at the sides into an elongated columnar epithelium, which bends round the structureless membrane so that it covers the whole underside of the horizontal bar of the T. These parts correspond to the lateral lobes or "Flinmerstreifen," described by the Hertwigs in the Actiniaria and by E. B. Wilson (27) in the Alcyonaria. Mucous cells are more abundant than in the stomodoeum and lie principally at the sides; small glandular vacuoles densely crowded with relatively large granules are found also in the same position, but vary very largely in abundance in different polyps. Nematocysts do not become numerous until the convoluted portion of the filament commences, when the goblet vacuoles gradually decrease and finally disappear (Fig. 13). Near the stomodoeal end of the mesenteries the nematocysts lie almost entirely at the sides of the filament, but towards the base they occur in dense masses throughout.

The filaments of the tertiary mesenteries, as in *Fungia*, are very similar to those of the primaries and secondaries but slightly smaller. The goblet vacuoles are not nearly so numerous, and do not form a well marked clearer area in the centre.

Mesenterial Nematocysts (Figs. 14—19). The nematocysts of the mesenterial filaments are about .033 mm. in length, and are found in every stage of development. They differ from the tentacular nematocysts in that they are relatively much broader, and are from the youngest stage of about the same size as the ripe nematocyst. The thread is much thicker with fewer coils, and its lower part, when ejected, is formed by an eversible portion of the cell. The structure of the ripe nematocyst (Fig. 14) is very similar to that of the nematocysts from the stomodoeum of *Euphyllia*, described and figured by Bourne (4), and those of *Caryophyllia* by Möbius (20) and Iwanzoff (17). The eversible portion is never so long as in *Caryophyllia*, and is not indeed usually more than about one-third the length of the whole cell (Figs. 14 and 17). The end of the thread projects in the centre of this to the somewhat pointed extremity of the cell. Around the eversible base is a single spiral row of short hairs, with about

fourteen turns instead of three rows as described in *Caryophyllia*. I could not distinguish in the thread any spiral band as found in *Caryophyllia*, nor any peculiar armature at the tip as in *Euphyllia*. The thread is very thick, and lies in the ripe condition close under the exterior membrane, which it may bulge out slightly (Fig. 14). It is coiled from 8 to 10 times on itself, and ends below in a granular mass of protoplasm at the base of the cell. The latter lies at some small distance from the structureless membrane in a protoplasmic bed connected by one or more fibres with the nervous layer.

It is extremely difficult to see the mode of eversion of the nematocyst, but generally the thread appears to be extruded first, and to carry with its lower end the eversible base (Fig. 15). Sometimes, the latter can, when the thread is partially extruded, be seen to be partially everted, and in one case I found it completely everted with the thread quite distinctly visible in the middle (Fig. 16). It does not, however, in any way approach the condition described and figured by Möbius (20), for the everted nematocysts of *Caryophyllia*. When the thread is partially, or but recently extruded, there appears to be a distinct cavity left in the protoplasm (Fig. 16). In sections too the thread appears to have a distinct sheath, which is quite separate from the eversible basal portion.

Besides these ripe nematocysts, a large number are found having the eversible base with central thread well marked, the rest of the nematocyst staining very uniformly of a light brown colour in iron haematoxylin and eosin (Fig. 17). In a few of these cells I found a large nucleus near the base, in one with a well marked nucleolus. A differentiation of the protoplasm into a slightly darker band, running spirally round the cell is next seen (Fig. 19), and from this up to the fully developed thread every stage is clearly visible. The darker band first appears at the outer end—in respect to the structureless membrane—of the cell, and the thread develops from this end towards its base.

In the filaments the nematocyst thread is often found completely extruded with the cell *in situ*. In other cases the cell is partially or completely extruded from the filament, but it is impossible to say how far this may not be due to pressure brought about by the strong contraction of the polyps. I have been unable to find any appearance of developing nematocysts other than those previously described,—with the possible exception of the nematocyst represented in fig. 18—and it seems to me to be probable that the thread becomes detached somewhere beyond the eversible base, which is then retracted, a new thread being formed. In some of the extruded nematocysts the thread seems to have been broken off in this way, but there is no appearance in the eversible base of myophan bands. In one extruded nematocyst there is a well marked nucleus at the base, and in several ripe nematocysts I have found a more darkly staining mass within the thread, but with sections only it is almost impossible to speak with certainty on such points.

Calicoblastic Ectoderm (*c. ect.* Fig. 20). The polyp next the corallum is everywhere covered by a thin layer of ectoderm, the calicoblast layer. This is not generally very well marked, and in sections looks like a thin line of tissue, slightly swollen in places where the small, round, homogeneously staining nuclei are situated. The nuclei

do not appear to be especially massed in any position, and near the base of the polyps are very distant from one another.

The layer however appears to be complete, and to separate the structureless membrane everywhere from the corallum except at the attachments of the mesenteries, and dividing walls of the coenosarcal canals outside the calices. Three structureless membranes join one another in these positions (Fig. 20), and at their junction a number of small bands are given off, which broaden out at their ends, and are directly attached to the corallum. In section these bands are seen to be striated, and the calicoblastic ectoderm between them is especially well developed, almost completely filling up their interspaces. In some polyps, especially at the bases of the mesenteries, the striations appear to run for some distance into the structureless membrane and to be due to fibres, but generally it appears quite structureless.

In oblique sections the bands have the appearance, represented by Sclater (25), in *Stephanotrochus*, and appear to have no connection with the structureless membrane. Sclater believed these blocks to be the calicoblasts, but Bourne (4), and subsequently Fowler (10), pointed out their real nature. In *Coenopsammia* they are short and have rather broad bases of attachment to the structureless membrane of the mesenteries, while at the attachments of the dividing walls of the coenosarcal canals they are generally very long, much narrower, where they leave the structureless membrane, broadening out very greatly at their ends. The spaces between them, in the latter position, are crowded with nuclei, and they often present in thick transverse sections (10—12 μ) almost exactly the same appearance as represented by von Heider (13), for the calicoblasts in the same position in *Dendrophyllia*, a closely allied genus (12. Taf. XXXI. Figs. 8, 9 and 11). I have too very carefully examined the calicoblasts, together with their attaching bands from the same position in undecalcified and partially decalcified preparations of *Coenopsammia* and other Madreporaria, and I can confidently state that neither in them nor in the calicoblasts are there any crystals of any sort. In decalcified preparations of *Pocillopora* (5 species), *Seriatopora*, *Prionastraea*, *Madrepore* and *Coenopsammia*, I have found no trace of any organic tissue or remains in the corallum, other than that due to Clione or boring algae, and there does not seem to be any room for doubting von Koch's conclusion (18), that the corallum lies completely outside the animal, and is the result of secretion by the calicoblastic ectoderm, the elements of which retain their own organic existence.

Endoderm. (end. Figs. 5, 20—22). I found it impossible in the hardened and preserved specimens to tease out separate cells from the endoderm, and in sections no cell outlines can be seen. In the coenosarcal canals and generally in the contracted polyp above the tentacles and over the corallum, the endoderm consists of a ragged much vacuolated epithelium of a cubical facies with large round granular nuclei with distinct membranes together with a few scattered mucous cells (Fig. 5). Over the muscles and between the attachments of the mesenteries to the external body wall it has a very elongated columnar facies with small oval or round, deeply and homogeneously staining nuclei with a few of the larger granular nuclei (Fig. 21). The structureless membrane is irregularly drawn out under the endoderm into processes, to which fibres from the endoderm appear directly to be attached, one or more corresponding to each nucleus.

No trace of a definite nervous layer can usually be distinguished, except at the attachment of the mesenteries to the body wall under the tentacles, where it is sometimes well marked with numerous small round nuclei.

The great mesenteric retractor muscles (Fig. 21) are situated on simple or branched lamelliform folds of the structureless membrane. They consist of separate long fibres, rectangular or oval in transverse section, and stain very deeply and uniformly with Heidenhain's iron haematoxylin. Each fibre runs from the mouth-disc to its insertion along the line of the attachment of the mesenteries as shown in Figure II. At each end the fibres break up into a number of small fibrils, which spread out and appear to be attached to the structureless membrane without any connection with the endoderm epithelium. At the attachment of the mesenteries to the corallum some of these fibrils run directly into the structureless membrane, and I would suggest that the fibres, previously described in this position, are really the attaching fibrils of these muscles.

The circular muscle—Röttken's muscle—consists of similar but much smaller fibres (Fig. 5), the attachment and course of which I have, however, been unable to satisfactorily determine.

On the sides of the mesenteries opposite to the great retractor muscles, I have been unable to distinguish any similar muscular fibres running transversely to the long axis of the polyp—any protractor fibres in fact. In sections numerous small muscular processes are cut across, but these are quite short, and are basal processes of the endodermal epithelium. Further, they do not seem to run markedly more transversely than longitudinally. As the polyp is very closely attached to the corallum, they could not either have any powerful protractor action, and it seems to me that the expansion of the polyps must be brought about by other means.

Generative Organs. I have not been able to trace the inwandering of the generative cells from the endoderm into the structureless membrane, but there is little doubt that it occurs in the same way as the Hertwigs have described in the Actiniaria (14 and 15). The endoderm round each ovum is very much thickened, and in the contracted condition of the polyp the coelenteron between the mesenteries is almost completely obliterated (Fig. 22). No cell outlines can be distinguished, but the endoderm appears to be a very elongated and much vacuolated epithelium of a columnar facies. The nuclei, which are small and not very distinct, are situated towards the free side of the epithelium, which is very granular. Near the base of the epithelium a few granules are found, which in places appear to be passing into the ova, large granules being constantly seen situated partially in the ova and partially in the endoderm.

The structureless membrane completely surrounds each ovum as a very thin layer and the membrane connecting it with the general structureless membrane of the mesentery is exceedingly fine. It can usually be distinguished, however, by the well marked basal muscular processes of the endoderm, which are not generally found over the ova. I have not found any definite "Fadenapparat" as described by the Hertwigs in Actiniaria, nor is there any trace of any of the ova serving for food to the rest.

The ova vary up to .45 mm. in diameter and are full of yolk spherules and granules. The nucleus is a large centrally situated body with a homogeneous deeply staining round nucleolus. No definite nuclear membrane can be distinguished. Towards

the exterior under the structureless membrane there is commonly found a thin layer of granules exactly similar in appearance to the granules found at the bases of the overlying endoderm.

SECTION IV.

CONCLUSIONS RELATING TO THE BODY LAYERS IN THE ACTINOZOA.

The central glandular elements of the mesenterial filaments have been shown by the Hertwigs (14) and McMurich (22) for the Actiniaria, and E. B. Wilson (27) and Hickson (16) for the Alcyonaria to be the elements, which produce the digestive secretion. Similar scattered glandular elements have been recorded by most observers in the stomodoea of Actiniaria and Madreporaria, and recently have been found also by Ashworth (1) in the stomodoeum of *Xenia*. The abundance and regular arrangement of the glandular elements, found in this species of *Coenopsammia* has however not previously been observed. In longitudinal sections through the mesenterial filaments and stomodoeum it is impossible to tell where the latter ends and the former commences so complete is the resemblance between the epithelia of these two parts. The epithelium too of the lateral parts, the "Flimmerstreifen" is precisely similar to that of the stomodoeum between the attachments of the mesenteries. It is important also to remember that the mesenterial nematocysts are found on all the three parts of the filaments and also in the stomodoeum and external ectoderm of the body.

It was suggested first by E. B. Wilson (27) that the lateral parts or "Flimmerstreifen" of the Actiniarian mesenterial filament are ectodermic in origin and that the median part, or "Drüsenstreifen," is endodermic. Fowler (7) however from the histology of the Madreporarian filaments considered the median part to be ectodermic and the lateral parts to be its unbroken gradation into the endoderm but mainly endodermic. H. V. Wilson (28) then from the development of *Manicina* came to the conclusion that the whole filament is ectodermic in origin. Indeed he showed that the filaments of the twelve primary mesenteries are formed as outgrowths from the basal end of the stomodoeum. McMurich (22) would not admit the homology of the lateral parts of the Madreporarian filaments with the "Flimmerstreifen" of the Hertwigs and maintained the views of E. B. Wilson.

In this species of *Coenopsammia* it is obvious that if the central part of the filament is endodermic, a great part of the wall of the stomodoeum is likewise endodermic. Ashworth (1) however states that in *Xenia*, where digestive cells also occur in the stomodoeum, he has followed the development in the bud and that the stomodoeum is entirely ectodermic. I have also found that the stomodoeum is entirely ectodermic in its origin in the buds of *Pocillopora*. In this species of *Coenopsammia* the glandular elements are found right up to the mouth of the stomodoeum and in the bud formation, so far as I could follow it, the whole stomodoeum appears to be formed by the ectoderm. The lateral parts of the mesenterial filaments are similar in structure to the "Flimmerstreifen" of the Hertwigs and have apparently the same function.

They too are directly continuous with the stomodoeum and have the same structure, so that from the histology *one must come to the conclusion that the whole filament of the primary and secondary mesenteries is ectodermic in origin*. It would appear also most probable that the filaments of the tertiary mesenteries are likewise ectodermic.

I have already pointed out that the central glandular elements of the mesenterial filaments have been shown to produce the digestive secretion in both the Actiniaria and in the Alcyonaria. In one polyp of *Coenopsammia*, which I have examined by transverse sections, a small Crustacean is lying in the coelenteron, where it passes into the stomodoeum. It is noticeable that in spite of the strong contraction of the polyp it is supported by the mesenterial filaments alone. Willem (29) too has shown in several Actinians that the prey is always clasped by the mesenterial filaments after passing through the stomodoeum, and further has investigated the action of the digestive secretion on proteids, glycogen and fats. Both Hickson for *Alcyonium digitatum* and Willem for various Actinians have brought forward negative evidence to show that no particles of food are taken up in the solid form by the so-called endoderm. Particles of carmine are however readily seized and the chief excretive functions appear to lie in this epithelium. There are no secretory digestive cells in the so-called endoderm, and it follows hence that digestion must be brought about by the ectoderm of the stomodoeum together with its downgrowths over the edges of the mesenteries, forming their filaments.

The stomodoeum of Zoantharia and necessarily also of Alcyonaria is not comparable then to the stomodoeum of the Triploblastica but rather is, with the mesenterial filaments, the homologue of the whole gut. The so-called endoderm, giving rise to the muscular bands and generative organs and performing also the excretory functions, is then homologous with the mesoderm of Triploblastica. In the terms of the layer theory, of whatever value it may be, the Actinozoon polyp must then be regarded as also a Triploblastic form having definite ectoderm, endoderm and mesoderm.

Sedgwick (26) in 1884 pointed out the possible importance of considering the Actinozoon polyps in connection with the origin of metameric segmentation in Triploblastica, a view which was afterwards strongly supported by van Beneden (2) from his researches on the development of *Arachnactis*. The foregoing facts seem to me to give a strong support to this hypothesis. It is however beyond the scope of this paper to discuss either this question, or that of the relationship of the Actinozoon and Hydrozoon polyps.

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EXPLANATION OF PLATE XXXIV.

Lettering used throughout.

ect. Ectoderm. *end.* Endoderm. *s. m.* Structureless membrane or lamella. *c. ect.* Calicoblast ectoderm. *n. l.* Nervous layer of the ectoderm. *m. g. c.* Mucous gland cells. *g. g. c.* Granular gland cells. *m. n.* Mesenterial nematocysts. *t. n.* Tentacular nematocysts. *mus.* Muscular fibres. *ov.* Ovum. *m. f.* Mesenterial filaments. *m. 1* Primary mesentery. *m. 2* Secondary mesentery. *m. 3* Tertiary mesentery.

FIG. 1. View of a large colony from the side (cleaned corallum). Nat. size.

FIG. 2. A small colony from above. One parent and three daughter corallites. Nat. size.

FIG. 3. A single calice from above. 1, 2, 3 Primary, secondary and tertiary septa.

FIG. 4. Diagrammatical section of the ectoderm of the polyp outside the tentacles. Mucous gland cells (*m. g. c.*) are everywhere numerous, but the granular gland cells (*g. g. c.*) are only found near the base of the tentacles. Two kinds of nematocysts are found, of which the mesenterial form (*m. n.*) is much the less numerous. The granular nervous layer (*n. l.*) is not well marked except at the bases of the tentacles; in it a few large nuclei of nerve cells can commonly be distinguished.

FIG. 5. Section through the body wall at the sphincter muscle, the fibres (*mus.*) of which are small and flattened. No cell outlines can be distinguished in either the ectodermal or endodermal epithelia.

FIG. 6. Section through the middle of a single battery of nematocysts on one of the primary tentacles. The central part of the battery is packed with nematocysts under which the nervous layer is very conspicuous, while at the sides the ectoderm cells end in muscular processes on the structureless membrane.

FIGS. 7—10. Tentacular nematocysts. (Oc. 4, oil immersion $\frac{1}{12}$.)

FIG. 7. A ripe tentacular nematocyst with the thread fully formed. Outside the basal end is a conspicuous oval nucleus in a finely granular mass of protoplasm, which forms the granular (nervous?) peduncle.

FIG. 8. A ripe tentacular nematocyst with the thread partially extruded, found lying freely in the cavity of one of the retracted tentacles.

FIG. 9. Developing nematocyst. In place of the extruded nematocyst a homogeneous mass of protoplasm appears, the central part of which acquires a definite membrane and becomes finely granular.

FIG. 10. Later stage than Fig. 9. The young nematocyst decreases in size and becomes coarsely granular, the granules arranging themselves in a spiral line close under the external membrane. The nematocyst drawn has been cut rather obliquely so that in the upper half the granules of the lower side are seen, and in the lower half those of the upper side, the granules in the centre appearing to be almost irregularly arranged. A comparison with Fig. 7 will make this clear.

FIG. 11. Transverse section through the stomodoeum showing the attachment of three mesenteries. The epithelium of the stomodoeum is very thick—being formed apparently of cells of an elongate columnar facies—and opposite to the attachments of the mesenteries crowded with goblet-like vacuoles.

FIG. 12. Transverse section through a primary mesenterial filament immediately before its convolutions commence. The structureless membrane ends in a T-shaped expansion in the filament, which is well marked off from the general endoderm of the mesentery. It is distinctly divided into three parts, a central, crowded with goblet vacuoles, and two lateral, crowded with homogeneously staining oval nuclei. A single nematocyst is seen in the central part, but the nematocysts do not become numerous until its lower half is reached.

FIG. 13. Transverse section of the same filament as in Fig. 12 in its lower third. The filament is as distinctly marked off from the endoderm of the mesentery below it, but it is no longer divisible into three parts, being crowded with nematocysts in different stages of development—one with the thread extruded and cut off short.

FIGS. 14—19. Mesenterial nematocysts. (Oc. 4, oil immersion $\frac{1}{12} \times \frac{2}{3}$.)

FIG. 14. A ripe nematocyst. The thread ends below in a mass of granules at the base of the cell while the opposite end appears to lie freely in an eversible sheath, marked by fine lines due to a spiral row of fine hairs. (Somewhat diagrammatical.)

FIG. 15. Nematocyst with part of the completely ejected thread. The thread seems to be extruded first and to carry behind it its eversible base, which is surrounded by a distinct row of spiral hairs. At the upper end of the nematocyst, round the eversible base of the thread, is a distinct depression.

FIG. 16. Nematocyst with ejected thread, which is still however visible in the middle of the basal portion. In the body of the nematocyst traces of a spiral sheath can be seen, from which the thread seems to have been ejected.

FIG. 17. Nematocyst with eversible base but without any appearance of a thread in the cell. Near the base is a nucleus with nucleolus (both seen very rarely) and the cell terminates in a nucleated peduncle, which branches out over the structureless membrane.

FIG. 18. Nematocyst possibly in an earlier stage to Fig. 17, without any distinct base for the thread and with a distinct nucleus and nucleolus.

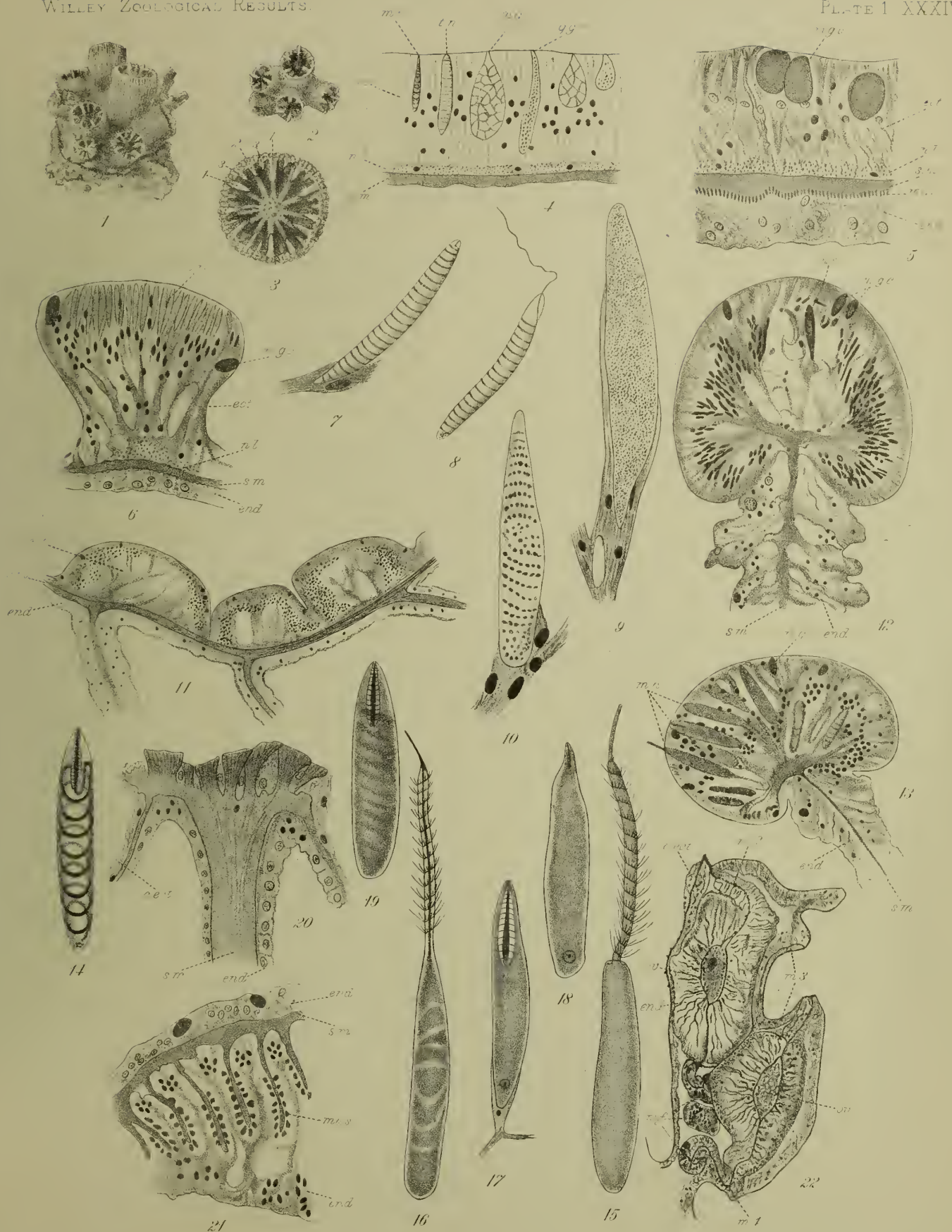
FIG. 19. Nematocyst of a later stage to Fig. 17, with a differentiation of the protoplasm into a dark spiral band, which will subsequently become the thread, lying in a clearer area.

FIG. 20. Section through the base of one of the dividing walls of one of the coenosarcal canals showing the attachment of the structureless membrane to the corallum. The former is drawn out into long striated bands, swelling out at their ends where they are attached to the corallum. The striations appear in some cases to be due to fibres in the structureless membrane, but they are not generally so well marked as in this section. The spaces between the bands are completely filled by the calicoblast ectoderm.

FIG. 21. Transverse section through a portion of a longitudinal retractor muscle of a primary mesentery. The structureless membrane is drawn out into simple or branched lamelliform folds, on which the somewhat rectangular or rounded fibres are placed.

FIG. 22. Transverse section through a primary and a secondary mesentery at a slightly lower level to that represented in the left half of sextant F in Figure I. The coelenteron is almost obliterated. The tertiary mesenteries (*m. 3*) are recognisable as fine bands. Neither the primary nor secondary mesenteries have any trace of muscular bands but in the structureless membrane of each an ovum is situated. Round these the endoderm is much thickened; its nuclei are generally indistinct but towards the free surface it is crowded with fine granules. Over the structureless membrane a few larger granules are found and can be seen in every stage of their passage into the ova, where they form a row of granules round the periphery. The nucleus of the ovum is large with large nucleolus; no nuclear membrane however is generally visible.

ZOOLOGICAL LABORATORY,
January 31, 1899.



J.S.G ana Edwin Wilson del.

GARDINER. COENOPSAMMIA.

ON THE INSECTS FROM NEW BRITAIN.

By D. SHARP, M.A., M.B., F.R.S.

With Plate XXXV.

THE insects obtained by Dr Willey in New Britain and Lifu have already been the subject of a paper in the first part of these "Results".¹ The specimens of hexapodous Insects brought back by Dr Willey are fairly numerous. Except in Coleoptera and Orthoptera they are all from New Britain. The number of species in comparison with the number of the specimens is very large, so that the collection is not of a kind that it is desirable to work out in complete detail. They show that New Britain is rich in insects, for unless this were the case it is impossible that Dr Willey should have obtained so many species as he did; entomological research having been only subordinate to some other objects of his expedition; besides which it must be recollected that his researches were confined to one or two localities on the coast.

Very little work has at present been published on the Entomology of New Britain. And even in the case of New Guinea—the larger island of which New Britain is so near a neighbour—the fauna has only been very imperfectly ascertained. In these notes I propose only to touch on certain species that can be advantageously dealt with.

As no allusion is subsequently made in this paper to certain of the Orders of Hexapoda I may here mention that the Neuroptera are represented by very few specimens, and that the Hemiptera have been entrusted to Mr G. W. Kirkaldy for examination. The latter are extensive in comparison with the other Orders, and it is not probable that Mr Kirkaldy's account of them will be ready in time to be included in these "Results." Lepidoptera are represented in the collection by only a few larvae and pupae².

¹ "Account of the Phasmidæ, with notes on the Eggs," pp. 75—94, Plates VIII. and IX. Dr M. v. Brunn has since published (*Mt. Mus. Hamburg*, xv., 1898, p. 4) a note on the egg referred to on p. 89 and Pl. IX. f. 39 as that of a *Cyphocrania* without name, and for which the name of *C. hanitschi* was suggested. According to Dr v. Brunn, this insect is really the *Cyphocrania herculeana* of Charpentier, Westwood having been wrong in treating Charpentier's species as a synonym of *C. goliath*. Herr Brunner v. Wattenwyl, in his expected monograph of Phasmidæ, will separate these two species as a genus with the name *Eurycnema* Serv.: the name of this Phasmid will therefore be *Eurycnema herculeana* Charp.

² An account of the butterflies of New Britain has recently been published by Herr C. Ribbe in *Deutsche ent. Zeitschr. Lep.*, 1898, pp. 35—133.

ORDER **Coleoptera.**

The collection of Coleoptera obtained by Dr Willey in New Britain numbers about 160 species. In 1883 Fairmaire published an essay on the Coleoptera of the New Britain archipelago¹ in which he enumerated 176 species. Since then but little has been added. Upwards of one half of the species mentioned by Fairmaire are not represented in Dr Willey's collection; moreover the majority of the species enumerated by Fairmaire really came from Duke of York island.

In the following remarks I have mentioned only such names as add to the knowledge supplied by Fairmaire's paper. Many of the species procured by Dr Willey are clearly undescribed, but I do not think it desirable to deal with the obscure forms that are represented only by one or two specimens, or with others that cannot for various reasons at present be satisfactorily elucidated.

Dr Willey also procured a small collection of Coleoptera in Lifu. This is at present being studied by M. Albert Fauvel of Caen, who is well acquainted with the Coleoptera of New Caledonia.

FAMILY LUCANIDAE.

Eurytrachelus intermedius Gestro, Ann. Mus. Genova, xvi., 1881, p. 317.

Plate XXXV. Figs. 3 *a*, 3 *b*, 3 *c*, 3 *d*.

Dr Willey procured a good series of this rare stag-beetle in the neighbourhood of Blanche Bay; nine specimens are of the teleodont form (Plate XXXV. Fig. 3 *a*), two of the mesodont form (Fig. 3 *b*), and two of the priodont (Fig. 3 *c*). There are also four females (Fig. 3 *d*). The forms of the male, besides differing in the mandibles, exhibit great variation in the sculpture. Gestro described the species from New Guinea, and Dr Willey's examples differ a little from Gestro's figure; chiefly in that the mandibles are more slender and their teeth less largely developed. A specimen in the British Museum, reputed to be from Duke of York island, quite agrees with the New Britain specimens. *E. intermedius* is closely allied to *E. ternatensis*. The latter species is recorded by Fairmaire from Duke of York island, but we may anticipate that this record will prove erroneous: *E. intermedius* having been probably mistaken for *E. ternatensis*.

FAMILY SCARABAEIDAE.

Phaeochrous alternatus Fairm. (t.c. p. 5). Several specimens of this beetle were taken from the stomach of *Varanus indicus*. It was not otherwise noticed.

? *Xylotrupes gideon* L. Plate XXXV. Figs. 1, 2.

Xylotrupes gideon is recorded from Duke of York island by Fairmaire, without any remark as to its variation. The four specimens of a male *Xylotrupes* procured by Dr Willey represent various grades of development of the horns of that sex, and

¹ Ann. Soc. ent. Belgique, xxvii., 1883, Pt. II., pp. 1—58.

are of some interest as they exhibit no sign of the secondary projection on the lower horn, that is invariably found on the specimens of *X. gideon* from India and Java. It is not possible in the present state of our knowledge to form an opinion as to whether these examples are a different species or not. M. van Lansberge has described a Dynastid from the island of Flores (*Endebius florensis*) the male of which is said to be very similar to that sex of *Xylotrupes gideon*, while the female is so different that van Lansberge has proposed a distinct genus for the species. Dr Willey brought back only one female that could possibly be the other sex of the male we are discussing, but there is no certainty that it is so, and if the two insects are really the sexes of one species, it is clearly not *X. gideon*.

We have figured the profile of the head and thorax of a Javanese example of *X. gideon* (Plate XXXV. Fig. 2) for comparison with our New Britain insect.

FAMILY MALACODERMIDAE.

There have long been known to entomologists some extremely remarkable larvae that probably are those of Lampyrides, or Lycides, though none of them have been satisfactorily identified¹.

Dr Willey procured a most remarkable form of this kind, bearing long abdominal processes, that are segmented or articulated at the base (Plate XXXV. Figs. 4, 4 *a*, 4 *b*). I take this opportunity of drawing attention to these forms with the hope that some one may soon be able to give us some further information about them. Although the larvae I have mentioned as being presumably those of Lampyrides or Lycides, are of very diverse forms, yet they all have a head with well-developed mouth-parts, and capable of being retracted into the tubular cavity placed underneath the shield-like prothorax. They have also well-developed prothoracic legs terminated by a single claw. It is probable that they may prey on Mollusca.

FAMILY CERAMBYCIDAE.

Arrhenotus willeyi, n. sp. Plate XXXV. Fig. 5.

Niger, parum nitidus, pube albicante variegatus, in elytris fasciis duabus flammulatis; prothorace, utrinque biangulato, tuberculo inframarginali, elongato, acuto. Long. 20—25 mm.

Head a good deal narrower behind the eyes, sparingly and irregularly punctate, variegate with a few white spots. Thorax strongly transverse, a good deal narrower than the elytra, dorsum a little uneven, irregularly and variably spotted with white: on each side the margin forms in front a well-marked prominent angle, and in the middle a much more obscure obtuse angle; below the margin there is an acute spine, white above, black below. Scutellum white on each side, black in the middle. Elytra much produced on each side of the scutellum, and with a small angle projecting inwardly

¹ It appears probable that a fossil larva of this group has been mistaken for a Crustacean allied to Apodidae. Cf. Gahan, *Natural Science*, XII., 1898, p. 42.

from the front part of the bay formed by their prominence; base with a short carina projecting angularly at the shoulder: their surface marked with irregular and variable white spots, the largest of which are combined to form two transverse bands, very much indented, the anterior band is directly transverse, the posterior one strongly angulate, projecting forwards at the suture; behind these two bands some irregular white spots: the sculpture variable, there being some subseriate punctures, and the interstices being more or less longitudinally raised; the punctures at the basal parts of the sides are very numerous and coarse: tips truncate, each with a broad short spine externally. Under-surface, irregularly variegate with white.

The three individuals of this species are probably two of them female, one male; if so there is very little difference between the sexes.

Thomson and Pascoe established several genera for the allies of *Arrhenotus* which were subsequently treated by Lacordaire as mere sections. *A. willeyi* does not enter satisfactorily into any of these sections. In coloration and general appearance it somewhat resembles *Elais exarata* Pascoe. (Trans. ent. Soc. London (3) III., Pl. XIX. Fig. 7.)

Tmesisternus yorkensis.

Sphingnotus yorkensis Fairmaire, Naturaliste, 1881, p. 359: Ann. Soc. ent. Belgique, XXVII., 1883, p. 47.

I refer a series of examples to this species notwithstanding the fact that they belong to the genus *Tmesisternus*, not *Sphingnotus*, and that they present some differences from Fairmaire's description. The punctures of the elytra are not serially disposed; the apical markings of the elytra and those on the abdominal segments are variable. The series procured by Dr Willey consists of 20 males and 12 females. The size varies from a length of 19 to one of 27 mm., and this variation occurs equally in the two sexes. The peculiar swelling of the middle tibiae of the male also varies greatly, as does the sculpture on the anterior aspect of the swollen part. The males and females are very much alike, but can be invariably distinguished by the last ventral plate. This is longer in the female and is more or less longitudinally impressed along the middle, the impression behind becomes much broader. The male has no trace of this impression, and has more abundant dark hair on the apical part of the segment. In both sexes the hind angle of this plate projects back as a short spine, longer in the female than in the male.

Fairmaire's specimens were from Duke of York island. Not suspecting at first that Dr Willey's specimens belong to Fairmaire's species, I had proposed to give them the name of *Tmesisternus tardus*. Dr Jordan has described an allied form from New Guinea under the name of *T. dohertyi*, Nov. Zool. I. p. 500, and remarks that it is near *T. yorkensis* Fairm.; it was this remark that led me to the above identification, which I believe will prove to be correct.

Diochares basigranatus Fairm. (t.c. p. 51). I think Fairmaire is correct in considering this distinct from *D. fimbriatus*. Dr Willey obtained two specimens of *D. basigranatus*. Fairmaire records (l.c.) *D. fimbriatus* from Duke of York island.

Monohammus fasciatus Montrouzier (Ann. Soc. Agric. Lyon, vii., 1855, p. 63).

Two specimens, agreeing with others from Woodlark island and New Guinea in my collection. Fairmaire records three other species of the genus from Duke of York island. Dr Willey obtained seven specimens, belonging possibly to four different species, near Blanche Bay, but this material is not adequate for the description of new species in the very difficult group of *M. xylotheques*, to which these forms belong.

Batocera lactiflua Fairm. (t.c. p. 50). Fairmaire's type was a female, entirely white in colour. Dr Willey has obtained a single female of this peculiar species, but it is of a griseous colour, deeply suffused with pink.

Batocera nebulosa Bates (P. Zool. Soc. London, 1877, p. 158). Recorded both by Bates and Fairmaire from Duke of York island: now obtained by Dr Willey in New Britain.

Xiphotheata luctifera Fairm. (Le Naturaliste, 1881, p. 359) Pl. XXXV. Figs. 6, 6a, 6b; Ann. Soc. ent. Belgique, xxvii., 1883, p. 49. There appear to be only two species known of this rare and peculiar genus. Fairmaire grounded his species mainly on the fact of the male being destitute of the peculiar long horn on the front coxae, a character that is very conspicuous in *X. saundersi*. Dr Willey procured three males and one female of a *Xiphotheata* that I refer to Fairmaire's species. They show that the male character mentioned above is merely an individual one; the horn being present and very largely developed in two of these males (Plate XXXV. Fig. 6), and only a short spine in the other (Fig. 6a). The female is easily distinguished by the entire absence of armature on the front tibia (as well as by the unarmed coxa, Plate XXXV. Fig. 6b) and by the terminal ventral plate not being prolonged at the sides behind. Fairmaire's species may however be maintained, as the colour and sculpture are a little different from those of *X. saundersi*. This latter species was found by Wallace in Batchian, Morty, and Gilolo. Fairmaire's specimen was from Duke of York island.

Serixia longicornis Pascoe (Tr. ent. Soc. London, 3rd ser. iii. p. 339). Two specimens. Previously recorded from Singapore, Ceram, Batchian, Bouru, and (with doubt) Waigiou.

Glenea extrema, n. sp. Rufotestaceus, antennis nigris; capite thoraceque ochraceo-tomentosis, hoc medio macula nigra ornato; elytris cyaneis, tomento griseo obscuratis, apice truncato, singulo angulo externo breviter spinoso, interno recto; pectore abdominisque lateribus ochraceo-tomentosis. Long. 13 mm.

Antennae slender, rather longer than the body (in the male?), quite black. Thorax not quite so long as broad, a little constricted in front of the base. Elytra with numerous large punctures irregularly arranged and wanting behind, cyaneous, but both colour and sculpture rendered obscure by a dense, pallid, griseous tomentum; there are numerous erect hairs at the shoulders: the humeral angles are sharply marked, from each there extends backwards a carina that becomes obsolete before reaching the apex: very near to this more dorsal carina there is a second one that does not commence at the base, but becomes more definite behind, and projects so as to form the terminal spine: the epipleural margin is also strongly raised: the sculpture on the pseud-epipleurae is very coarse, and the purple (or violet) colour is not obscured by tomentum as it is on

the dorsum. The claws are very strongly toothed at the base. Four specimens, very similar to one another, and probably all males. The species appears to be nearer *G. aluensis* than any other.

Glenea venus Thomson. One specimen.

FAMILY BRENTHIDAE.

CACOSCHIZUS, n. g. (Ceocephalides).

Tarsi quinque-articulati; articulis 1° et 2° transversis, 3° quadrato, superne latissime fere ad basin impresso, margine apicali sat profunde emarginato, 4° 5°que crassis, 4° paulo ultra apicem tertii extenso, ab quinto bene discreto, hoc ceteris conjunctis longitudine fere aequali.

I establish this genus for a Brenthid with very peculiar feet. The species I believe is *Schizotrachelus schmeltzii* Fairm. Lacordaire in describing the genus *Schizotrachelus* (Genera Col. VII. p. 455) describes the tarsi as follows: "tarses spongieux en dessous, à articles 1—3 courts, égaux, 3 entier." In the structure of the feet *Cacoschizus* comes nearest to certain species of the genus *Trachelizus*, but from that genus it is readily distinguished by the head being separated from the neck by a very deep constriction.

Cacoschizus schmeltzii. Pl. XXXV. Fig. 7, ♂; 7 a, ♀; 7 b, hind foot of ♂.

Schizotrachelus schmeltzii Fairm., Ann. Soc. ent. Belgique, XXVII., 1883, Part II. p. 44.

Fairmaire described the male only, we figure the two sexes; in the structure of the feet the female agrees with the male. The peculiar tarsi are of considerable interest, as distinctly 5-jointed tarsi are of very rare occurrence in the Rhynchophorous series of Coleoptera. The resemblance of both the sexes of *Cacoschizus* to *Trachelizus* is very great, and though *Schizotrachelus* and *Trachelizus* are widely separated in Lacordaire's classification, I think they are nevertheless naturally allied.

CACOTRACHELUS, n. g. (Eutrachelides).

Mas. Caput elongatum, convexum; rostrum breve, apice latiore, mandibulis brevibus spatio parvo includentibus. Antennae breves, crassae. Prothorax convexus, subovalis, antérieur utrinque obsolete convexo, dorso posterior subtiliter canaliculato. Pedes breves crassiusculae, femoribus brevibus, basi haud pedicellato; tibiis brevibus compressis, apice interne mucronato; tarsis crassis, subtus spongiosis, articulo tertio breviter bilobato.

Lacordaire's group Eutrachelides consists of a single species of gigantic Brenthidæ—*Eutrachelus temminckii*—from Java. The genus I am at present establishing is totally different from *Eutrachelus* in appearance, but is I think really allied to it. I have long had in my collection a Brenthid from Java that is closely allied to the insect brought

by Dr Willey from New Guinea, and I will take this opportunity of briefly diagnosing it¹. The coloration of these insects is very unusual, exhibiting as it does the yellow lines of the South-American Brenthides in a somewhat different form. From a taxonomical point of view *Cacotrachelus* is of considerable interest, as it might almost as well be placed amongst the S. American Brenthides as near *Eutrachelus*.

Cacotrachelus sculptipennis, n. sp. Plate XXXV. Fig. 8 ♂; 8a ♀, head and thorax from side.

Nigricans, capite thoraceque metallescentibus, femoribus tibiisque flavo-rufis; elytris rufis, versus suturam piceis, interstitio tertio fere toto, 5° ad basin flavescentibus, crenato-sulcatis; capite thoraceque canaliculatis, illo ad verticem profunde impresso. Long. cum rostro, 8 mm.

Male. Rostrum broad and short, not so long as the thorax, thicker at the tip, deeply sulcate along the middle; head elongate convex, canaliculate, the channel expanding behind into a broad deep depression; separated from the neck by a very deep depression; the back of the head is somewhat depressed, and on each side with a small notch or fovea. Antennae inserted in the middle of the rostrum, thick and short, thicker towards the tip; joints 3—10 transverse, 9 and 10 distinctly longer than those preceding them, 11th joint acuminate, rather longer than broad. Prothorax longer than broad, rounded at the side and narrowed in front, convex, impunctate, very distinctly channelled behind, the channel finer in front, and not reaching the anterior margin. Elytra but little prolonged behind, truncate at the tip, the outer angle slightly obtuse and the lateral margin strongly raised behind; externally deeply grooved, the grooves very regularly sculptured, the interstices narrow, the first and second striae are fine, and the first, second and third interstices comparatively broad, the sixth interstice is somewhat more prolonged and raised at the extreme base. The legs are short, reddish-yellow, the trochanters and tarsi blackish, the knees a little darker; all the legs provided with strong angular mucro at the tip of the tibia; tibiae broad compressed, but less so in the middle than at the base and apex.

Female. Resembling the male, but with the rostrum slender, and only slightly thicker at the tip, the antennae inserted near the base, and the tibial mucros obsolete.

Ithystenus debilis, n. sp. Plate XXXV. Fig. 9 ♂.

♂. Niger, opacus, femoribus parte basali rufa, elytris flavo-lineatis, ad apicem acuminibus duobus, brevibus, simplicibus ornatis. Long. cum rostro, 23 mm.

Allied to the New Guinean *I. linearis*, but smaller, with the yellow lines of the elytra extending nearly to the tip, and the apical processes, simple points, without lobe or swelling at their bases. The hind tibiae are remarkably short, but the femora extend

¹ *Cacotrachelus javanus* n. sp. Picescens, pedibus rufis, piceo-variegatis; elytris regulariter crenato-sulcatis, dorso deplanato, apice subprolongato, truncato; externe, suturaque nigricantibus, interstitio tertio flavo, latiore, interstitiis 2° 4°que vage rufescentibus, 5° iterum flavescentiore; antennis crassiusculis, modice elongatis, apicem versus latioribus, articulis ultimis tribus paulo latioribus; tibiis intermediis et posterioribus parte supra medium crassiore. Long. ♂, cum rostro, 13 mm. Hab. Willis mountains, Java.

slightly beyond the tips of the elytra. Only one specimen was found. The occurrence of this remarkable genus in New Britain or the Duke of York island has not been previously noticed.

ORDER **Hymenoptera.**

New Britain is evidently rich in Hymenoptera, as the small number of examples obtained by Dr Willey consists of comparatively many species. They belong chiefly to the Aculeata. I have not ventured to describe any of them except a species of *Thynnus* that possesses a peculiar abdominal structure. I may however allude to an aberration of instinct observed by Dr Willey in the case of a wasp of the genus *Polistes* (probably an undescribed species allied to *P. colonicus*). Instead of one egg being placed in each cell, there are several, as shown in Fig. 14, Pl. XXXV., which represents five cells of the nest of the insect in question. The cell on the left, below, is closed for the purpose of pupation, and the one above it is empty. The three cells to the right contain, respectively, one 5, one 3, eggs, and the other (the one to the right) 2 just-hatched larvae. Notwithstanding the supernumerary eggs, only one larva in each cell attains maturity, though how the others are disposed of we do not know, Dr Willey having made no observations on this point. Neither did he ascertain whether this aberration is common in the species, or confined to this nest. He brought back the nest of a second, and smaller, species of *Polistes* (also probably undescribed), and in this case there is only one egg in each cell, as one would expect. It does not seem possible to account for so striking an aberration of instinct as this, by supposing that there were more eggs produced than cells to place them in, because several of the cells in the nest are quite empty.

FAMILY APIDAE.

KOPTORTHOSOMA sp.

Koptorthosoma sp. aff. *K. aestuantis*, Perkins, Ent. Mo. Mag., Feb. 1899, p. 38.

Mr R. C. L. Perkins has (l. c.) called attention to the very extraordinary symbiosis of female bees of the genus *Koptorthosoma* and certain Acarids; the bee being provided with a special chamber in the abdomen which is tenanted by the Acari. The males do not possess this structure; Mr Perkins mentions the remarkable fact that in this species from New Britain the female is destitute of the special chamber, though it exists in the closely allied *K. aestuans*. Dr Willey only procured two females of this interesting species, and no male.

FAMILY THYNNIDAE.

Thynnus serriger, n. sp. Pl. XXXV., Fig. 13, ♀; 13 a, extremity of abdomen.

♀. Nigricans, hic inde pallide setosus; scutello, abdominis maculis lateralibus, fasciaeque mediana in medio interrupta, albicantibus. Long. 12 mm.

Vertex of head shining, front densely and coarsely punctured and pubescent. Thorax transversely quadrate, rugose above, with a carina along the middle; the small scutellum almost white, very hairy. Propodeum with very little sculpture, abruptly declivous behind; the portion in front of the declivity very short. Abdomen with the first segment very deeply impressed in front, at the edge of the impression very hairy, especially in the middle; just behind the large impression there is a small depressed area, faintly metallic in colour, and coarsely punctured, but both the peculiar colour and sculpture are much concealed by the dense pubescence of this part. The second segment is covered above by coarse, transverse wrinkles, the following segments being smooth and polished. There is a pallid spot on each side of segments 1—4; that on the first segment stretches inwards towards its fellow, as does also that on the third segment; the spots on the 2nd and 4th segments are quite small. The peculiar plate at the end of the abdomen is terminated by a pair of saws (Pl. XXXV. fig. 13 *a*).

Only one specimen was obtained of this species. Though in form, colour and sculpture similar to various other species of the genus,—*T. atratus*, e.g.—it is remarkable on account of the pair of saws at the extremity of the abdomen. Thynnidae are believed to depredate on pupae or larvae of Lepidoptera underground, and it is possible that these saws may be useful in penetrating cocoons. So little is known as to the life-histories of these peculiar insects that this suggestion can be considered as little more than a random guess. Dr Willey did not obtain any male *Thynnus*.

ORDER Diptera.

Of this neglected Order of Insects the specimens brought back from New Britain are few. They were all placed in spirit, and consequently are mostly, since drying, in a shrivelled condition: this method of collection being unsuitable for insects of this Order. All the collection was made in New Britain: Dr Willey did not bring back any Diptera from Lifu.

In addition to the four species I have ventured to describe, the collection includes about 24 species. There are several Tipulidae of a commonplace character, looking like European insects. The family Stratiomyidae is represented by a pair of *Engonia consobrina*, and two species of *Pteticus*. The *Engonia* is of considerable interest on account of the great difference in the structure of the antennae of the two sexes. The male—which is twice the size of the female—has the intermediate joints of the antennae distinctly segmented, and the terminal three joints elongate, and densely hairy; the terminal joint being remarkably long. In the female the intermediate joints are closely compacted and swollen, and the terminal joint is short.

The family Therevidae is represented by a new species of *Leptipalpus* allied to *L. waigiensis* Bigot. Asilidae are apparently common in New Britain, a species of *Laphria* (*Maira*) very near to *L. aenea* Macq. being represented by twelve specimens, and there are also two or three species of *Ommatias*.

There are two species of Syrphidae in addition to the *Eumerus* described below. The Eumyiid Muscids are apparently numerous: the most remarkable being an apparently new *Rutilia* of very brilliant colours, but with the abdomen dark. Of Acalyptratae there are two forms allied to *Calobata*, and a species of *Senopterina*.

Speaking roughly these Insects seem to be allied to both Australian and Malayan forms.

FAMILY SYRPHIDAE.

Microdon pictipenne, n. sp.

Gracile, nigrum, coerulescenti-micans, hic inde aurato-pubescens, geniculis tarsisque testaceis; alis elongatis, hyalinis, nigro-pictis. Long. 10 m.m.

Head shining, violet; the face on each side with a broad line of golden pubescence; antennae black, with the basal joint yellow beneath, the third joint reaching nearly to the mouth, the seta inserted laterally near its base. Thorax violet, dull, bearing black pubescence, at the sides in front of the wings with golden pubescence; there are also some golden hairs on the scutellum and along the sides of the dorsum. Abdomen slender, shaped like that of a wasp, violet, the sides and hind margins of the segments with some golden hair. Femora violet, the base of the tibiae and the tarsi yellow, the front tarsi more obscure yellow. Wings elongate, reaching about to the tip of the body, transparent, the nervures very strongly marked, black, the apical portion of the wing with some irregular black marks extending across the wing. Halteres white. One specimen.

This species, like others of its congeners, has a pronounced general resemblance to Hymenoptera.

Eumerus speculifer, n. sp. Pl. XXXV. Fig. 10, hind-leg.

Niger, subaeneo-micans, abdomine lunulis albidis ornato, antennis geniculis, tarsisque sordide testaceis. Long. 7 m.m.

♂ Head black, between the eyes, above the antennae rendered snow-white by a very fine depressed pubescence: eyes meeting in front, and separated on the vertex by only a very narrow space. Antennae very short and broad, sordid yellow. Thorax black and shining, almost destitute of pubescence; the crenulations of the scutellum very deep, some of them projecting behind as minute denticles. Squama and antisquama white. Abdomen densely punctate, dull black, more shining at the base; the basal segment at the sides, with long, pale grey pubescence, on the dorsum with two small, white, almost round marks: the second and third segments each with an elongate, curved, white mark on each side. Legs black, extreme tips of femora and bases of the tibiae sordid yellow. Hind leg with the basal joint of the tarsus very much enlarged, and on the under side set with dense adpressed, pure white pubescence, which catches the light in certain directions, and looks like quicksilver; the following joint also somewhat enlarged; the under surface of the tibia also covered with white hair which is not adpressed. One specimen.

Van der Wulp has figured the leg of *E. argyropus* (from New Guinea) in Termes. Füzetek, 1898, Pl. XX. Fig. 6: in it the tarsus is less enlarged, and all the four following joints are simple and symmetrical. *E. argentipes* Walk., according to the type in the British Museum, has the hind feet very differently shaped.

FAMILY ORTALIDAE. (Muscidae acalyptratae.)

Lamprogaster austeni, n. sp. Pl. XXXV. Fig. 11 ♀; 11 a, 11 b, 11 c.

Thorace dorsoque abdominis viridi-purpureis, capite pedibusque flavis, illo vertice fusco; abdomine subtus membranaceo utrinque versus apicem vesiculo protuberante; alis subopacis, basi et dimidio anteriore aurantiacis. Long. 12 m.m.

Antennae received in deep, elongate ear-like depressions; first joint hardly visible, second moderate, third elongate, twice as long as the second, bearing at its base an arista twice as long as itself, and bare except for a few fine hairs at the base. Head yellow with the vertex broadly fuscescent along the middle, a dark streak on each side below the antennal cavity; palpi yellow, labellum blackish. Thorax metallic, shining, feebly pubescent, underface of scutellum yellow. Wings elongate, rendered dull by a dense distinct strigosity, the anterior part, and even the veins, dark yellow: squama very large, completely covering the halter. Legs clear yellow.

The metallic tint varies in colour, and may be in parts bluish or purplish.

The male has a large white, round vesicular prominence at each side of the abdomen (Fig. 11 b), and the genitalia project between the pair of prominences. The female has a very large, pap-like projection, instead of the round prominence of the male; at the tip, between the two paps, there is a rounded prominence from which projects the slender, two-segmented ovipositor (Fig. 11 c).

The peculiar, vesicular structures of the abdomen shrivel after the insect is taken from spirit and dried: and they also, I anticipate, only take on their full development in life when the insect is sexually mature and occupied with reproduction. The species is very like *L. elongata* van der Wulp (from Batchian) but independent of the abdominal structure it differs by its less elongate form, and by the colour of the undersurface of the abdomen and hind coxae being yellow.

I have named this remarkable fly in honour of E. E. Austen, Esq., of the British Museum, Natural History, who kindly assisted me in tracing its affinities. No one, unfamiliar with the intricate but unsatisfactory state of classification of Muscid flies would dream of assigning a place to this insect amongst the Acalyptrate Muscidae, as the halters are hooded in the most perfect manner.

GIRAFFOMYIA, n. g. Muscidarum acalyptratarum.

Corpus elongatum, nitidum, pubescentiae destitutum. Prothorax elongatus; caput liberum permobile, a thorace utrinque scleriti cervicale elongato separatum. Pectus valde prominulum, pedibus intermediis et posterioribus contiguis, a pedibus anterioribus longe remotis. Scutellum bispinosum. Caput marium interdum processu elongato ornatum.

This genus may be placed near *Angitula* Walker and *Phytalmia* Gerst. It is remarkable on account of the elongation of the neck and its peculiar articulation with the head by means of an elongate cervical sclerite on each side; and also by the prominence of the breast whereby the middle legs are rendered contiguous with the posterior pair, and are remote from the front pair. It also departs from *Angitula* by a slight peculiarity of the wing-nervuration, the 3rd and 4th veins being more widely separated and the cross-vein longer: in this respect it agrees with an insect from New Guinea, separated by Mr Austen in the British Museum collection as a new genus allied to *Angitula*. The genus *Phytalmia* Gerst. (Stett. Ent. Zeit. 1860, p. 169, Pl. II. Fig. 3) has much in common with *Giraffomyia* but in it the thorax is not elongated.

In some of the specimens the head is ornamented by a pair of peculiar large processes that are apparently capable of movement by aid of a constriction placed near the base. Several other Acalyptrate Muscids possess peculiar projections on the head. This is well known in the case of the genus *Elaphomyia*. The genus *Clitodoca* also possesses cephalic processes. In none of the forms is there however any trace of the projections being divided into two segments except in the case of *Giraffomyia*. It is very curious if it prove, as I expect it will, that so exceptional a structure should be present only in some of the individuals of the male sex of the same species. Of six specimens the two females do not possess the structure, and of the four males, one is entirely without it, while the other three possess it in very different degrees of development. When largely developed it is accompanied by a considerable change in the form of the eye. The genus *Phytalmia* has appendages somewhat like those of *Giraffomyia*, but not divided at the base.

Walker places *Angitula* in the subfamily Sepsides. Gerstaecker has assigned no position to *Phytalmia*.

Giraffomyia willeyi, n. sp. Pl. XXXV. Fig. 12, ♂; 12 a, profile of ♂; 12 b, front of head of male.

Gracilis, viridi-aenea, nitida, pedibus flavis, nigro-variegatis, alarum margine anteriore argute nigra; capite aurantiaco, vertice fusciscente, ad marginem interiorem oculorum albido-lineato. Long. 16 m.m.

Mas; capite utrinque processu magno, prope basin quasi articulado, apice laminam curvatam flavam, nigro-marginatam formante.

Of this curious insect Dr Willey obtained at least two males. The colour of the body and abdomen is a brassy-green, very shining. The head is pallid underneath the antennae; behind this it is of a tawny-orange colour, with a very fine white or silvery line close to the eye: the vertex is fusciscent. The elongate cervical sclerites connecting the head with the thorax are rather more than 1 m.m. long. The prothorax and abdomen are membranous beneath. The surface is very polished and free from pubescence, but there are punctures on the dorsal aspect of the thorax and some fine transverse wrinkles on the mesonotum. The long legs are yellow, with the tips of the femora and tibiae and with the long tarsi blackish. The wings are transparent, with the front margin coloured so as to form a very definite black stripe, and with this is connected a patch of black

colour along the antero-external cross-vein. The only setae are, one behind each eye, and a fringe of erect hairs along the free hind-margin of the vertex. The halteres are white and are placed at the junction of the perpendicular metanotum with the abdomen.

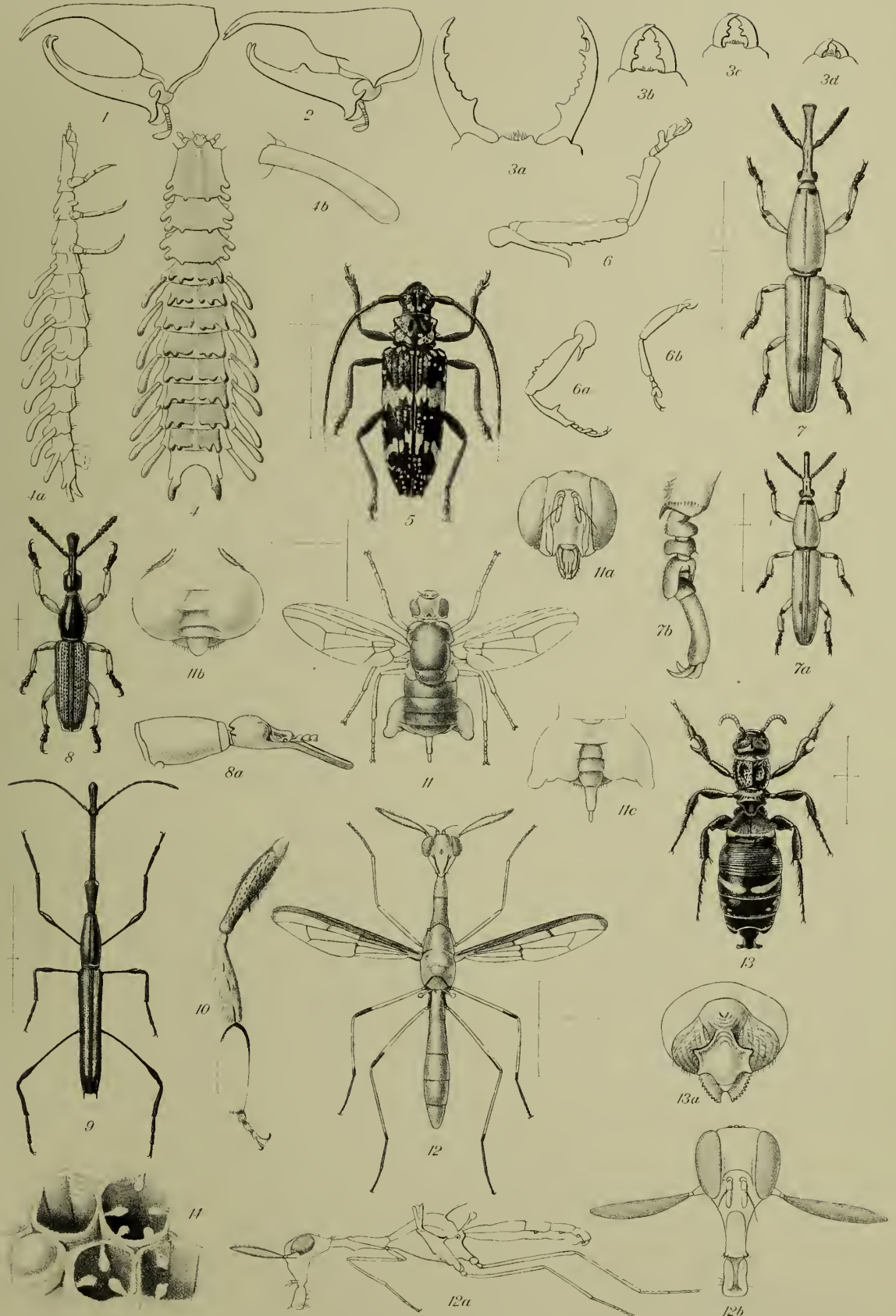
Although the specimens above alluded to are certainly males, they differ considerably in the form of the peculiar cephalic appendages. Each appendage consists of two parts: a basal portion, which is a direct continuation of the membranous undersurface of the head, prolonged immediately beneath the eye and causing a large emargination therefore; and a second terminal part, which is harder and separated from the basal part by a deep constriction; at this point the appendage appears to be capable of a great deal of movement. In one of the two specimens the basal prominence is very large; while in the other (Pl. XXXV. Fig. 12, 12 *a*, 12 *b*) it is quite small.

Besides the two individuals described in the above lines, Dr Willey brought back four other specimens considerably smaller in size, and concerning which I am in doubt as to whether they may be a distinct species or small examples of *G. willeyi*. Two of them are males, and two of them females. The smallest specimen is only 9 m.m. long. Both the females and one of the males are entirely destitute of the peculiar cephalic appendages, while the other male possesses a very small pair. I treat them as being a small form of *G. willeyi*.

EXPLANATION OF PLATE XXXV.

(Sharp, Insecta.)

- FIG. 1. Profile of head and thorax of *Xylotrupes gideon* (?), male, from New Britain.
- FIG. 2. Profile of head and thorax of *Xylotrupes gideon* male, from Java.
- FIG. 3. Front of head and mandibles of various forms of *Eurytrachelus intermedius* from New Britain; viz. 3 *a* teleodont ♂, 3 *b* mesodont male, 3 *c* priodont male, 3 *d* female.
- FIG. 4. Malacoderm Coleopterous larva; 4 seen from above; 4 *a* profile; 4 *b* one of the abdominal appendages more enlarged.
- FIG. 5. *Arrhenotus willeyi*.
- FIG. 6. Anterior legs of individuals of *Xiphotheata luctifera*; viz. 6 front leg of large male; 6 *a* front leg of small male; 6 *b* front leg of female.
- FIG. 7. *Cacoschizus schmeltzi* ♂.
- „ 7 *a*. „ „ ♀.
- „ 7 *b*. „ „ hind foot of ♂.
- „ 8. *Cacotrachelus sculptipennis* ♂.
- „ 8 *a*. „ „ Profile of head and thorax of ♀.
- „ 9. *Ithystenus debilis* ♂.
- „ 10. *Eumerus speculifer*, hind leg.
- „ 11. *Lamprogaster austeni* ♀; 11 *a* front of head; 11 *b* undersurface of abdomen of ♂; 11 *c* undersurface of abdomen of female.
- „ 12. *Giraffomyia willeyi* ♂; 12 *a* profile; 12 *b* front of head.
- „ 13. *Thynnus serriger* ♀; 13 *a* extremity of abdomen seen from behind.
- „ 14. Five cells from nest of *Polistes* sp. illustrating the aberration of instinct described on p. 388.



ON THE STOMATOPODA AND MACRURA BROUGHT BY
DR WILLEY FROM THE SOUTH SEAS.

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WITH PLATES XXXVI.—XXXIX.

DR WILLEY'S collection of Stomatopoda and Macrura contains in all 82 species, of which 20, rather less than a quarter, appear to be new to science. Notes on some of these, short lists of references to others, and brief diagnoses of the new species in the families Squillidae and Pontoniidae will be found in papers published by the Author in the *Proceedings of the Zoological Society*¹ and in the *Annals and Magazine of Natural History*².

The specimens were collected in New Britain, the eastern archipelago of British New Guinea, New Caledonia and the Loyalty Islands, and the New Hebrides.

In New Britain the following forms were obtained:—

1. *Protosquilla cerebralis* Brooks [Pigeon Island].
2. *Gonodactylus chiragra* (Fabr.) [Talili Bay, Ralun].
var. *anacyrus* nov. [Talili Bay].
3. *Odontodactylus scyllarus* (Linn.).
4. *Pseudosquilla ciliata* (Fabr.) [Blanche Bay].
5. *Lysiosquilla biminiensis* Bigelow, var. *pacificus* nov. [Blanche Bay].
6. *Penaeus fissurus* Bate [Talili Bay].
7. *Penaeus canaliculatus* (Oliv.).
8. *Stenopus hispidus* (Oliv.) [Blanche Bay].
9. *Atya moluccensis* de Haan [near Cape Gazelle].
10. *Periclimenes parvus* Borradaile [Blanche Bay].
11. *Periclimenes tenuipes* Borradaile [Ralun].
12. *Pontonia ascidicola* Borradaile [Blanche Bay].
13. *Palaemon lar* Fabr. [near Cape Gazelle].
14. *Palaemon weberi* de Man [near Schultze Point].
15. *Palaemonopsis willeyi* sp. n. [Ralun].

¹ P. Z. S., 1898, pp. 32, 457, and 1001.

² Ann. Mag. N. H. (7) 11, p. 377 (1898).

16. *Pandalus* (*Parapandalus*) *serratifrons* sp. n. [Blanche Bay].
17. *Pandalus* (*Parapandalus*) *tenuipes* sp. n. [Blanche Bay].
18. *Pandalus* (*Parapandalus*) *longirostris* sp. n. [Blanche Bay].
19. *Heterocarpus ensifer* A. M.-Edw. [Blanche Bay].
20. *Synalpheus biunguiculatus* Stimps. [Blanche Bay].
21. *Alpheus obesomanus* Dana [Blanche Bay].
22. *Alpheus laevis* Randall [Blanche Bay].
23. *Panulirus demani* nom. nov. [Blanche Bay].
24. *Callinassa novae-britanniae* sp. n.
25. *Eiconaxius tuliliensis* sp. n. [Talili Bay].
26. *Galathea elegans* Adams and White.
27. *Galathea grandirostris* Stimps. [Talili Bay].
28. *Munida scabra* Henderson [Talili Bay].
var. *longimanus* nov. [Talili Bay].
29. *Munida japonica* Stimps. [Talili Bay].
30. *Munida semoni* Ortm. [Talili Bay].
31. *Pagurus deformis* H. M.-Edw. [Pigeon Isl.].
32. *Pagurus asper* de Haan [Blanche Bay].
33. *Pagurus gemmatus* H. M.-Edw.
34. *Coenobita compressus* H. M.-Edw. [Palakuvur].
35. *Remipes admirabilis* Thallw. [Blanche Bay].
36. *Remipes ovalis* A. M.-Edw.
37. *Remipes celaeno* de Man [Blanche Bay].
38. *Albunea microps* Miers [Blanche Bay].

In New Guinea:—

1. *Periclimenes parasiticus* Borradaile [Milne Bay].
2. *Anchistus miersi* (de Man) [D'Entrecasteaux Group].
3. *Anchistus biunguiculatus* Borradaile [D'Entrecasteaux Group].
4. *Conchodytes meleagrinae* Peters [Conflict Group. Engineer Group].
5. *Pandalus* (*Parapandalus*) *tenuipes* sp. n. [D'Entrecasteaux Group].
6. *Saron marmoratus* (Oliv.) [Lousiades].
7. *Alpheus aglaopheniae* sp. n. [Engineer Group].
8. *Callianidea typa* H. M.-Edw. [Sariba].
9. *Petrolisthes hastatus* Stimps. [Sariba].
10. *Petrolisthes lamarchi* (Leach) [Sariba].
var. *fimbriatus* Borradaile [Sariba].
11. *Pagurus deformis* H. M.-Edw. [Conflict Group].
12. *Pagurus setifer* H. M.-Edw. [Conflict Group].
13. *Pagurus euopsis* Dana [Conflict Group].

In New Caledonia and the Loyalty Islands:—

1. *Protosquilla cerebralis* Brooks [Lifu].
2. *Protosquilla trispinosa* Dana [Lifu].

3. *Gonodactylus chiragra* (Fabr.) [Lifu].
 var. *smithi* Pocock [Lifu].
 var. *anancyrus* nov. [Lifu].
4. *Squilla multituberculata* Borradaile [Lifu].
5. *Pseudosquilla ciliata* (Fabr.) [Uvea].
6. *Periclimenes spinigerus* (Ortm.) [Lifu].
7. *Periclimenes lifuensis* Borradaile [Lifu].
8. *Coralliocaris inaequalis* Ortm. [Lifu].
9. *Leander pacificus* Stimps. [Isle of Pines].
10. *Rhynchocinetes typus* H. M.-Edw. [Lifu].
11. *Parhippolyte uveae* sp. n. [Uvea].
12. *Alpheinus tridens* sp. n. [Lifu].
13. *Synalpheus demani* nom. nov. [Lifu].
14. *Synalpheus neomeris* (de Man) [Lifu].
15. *Alpheus laevis* Randall [Lifu].
16. *Alpheus gracilidigitus* Miers, var. [Isle of Pines].
17. *Alpheus diadema* Dana [Lifu].
18. *Alpheus obesomanus* Dana [Lifu].
19. *Alpheus frontalis* Say [Lifu].
20. *Panulirus bispinosus* sp. n. [Lifu].
21. *Panulirus penicillatus* (Oliv.) [Lifu].
22. *Paribacus antarcticus* (Rumph) [Lifu].
23. *Scyllarus sieboldi* de Haan [Lifu].
24. *Galathea australiensis* Stimps. [Lifu].
25. *Galathea affinis* Ortm. [Lifu].
26. *Galathea spinimanus* sp. n. [Lifu].
27. *Porcellana sollasi* Whitelegge [Lifu].
28. *Petrolisthes bispinosus* sp. n. [Lifu].
29. *Petrolisthes lamarcki*, var. *fimbriatus* Borradaile [Lifu].
30. *Pachycheles sculptus* (H. M.-Edw.) [Lifu].
 var. *tuberculatus* nov. [Lifu].
31. *Pachycheles lifuensis* sp. n. [Lifu].
32. *Pagurus asper* de Haan [Lifu].
33. *Pagurus deformis* H. M.-Edw. [Lifu].
34. *Pagurus setifer* H. M.-Edw. [Lifu].
35. *Pagurus gemmatus* H. M.-Edw. [Lifu].
36. *Pagurus punctulatus* Oliv. [Lifu].
37. *Pagurus strigatus* (Herbst) [Lifu].
38. *Coenobita clypeatus* (Herbst) [Lifu].
39. *Coenobita perlatus* H. M.-Edw. [Lifu].
40. *Coenobita spinosus* H. M.-Edw. [Lifu].
41. *Coenobita compressus* H. M.-Edw. [Lifu].
42. *Coenobita rugosus* H. M.-Edw. [Lifu].
43. *Birgus latro* (Linn.) [Lifu].

44. *Remipes testudinarius* Latr. [Lifu].
45. *Remipes pacificus* Dana [Isle of Pines, Lifu].
46. *Remipes celaeno* de Man [Isle of Pines].

In the New Hebrides:—

Coenobita compressus H. M.-Edw.

The macruran fauna of the various localities, so far as it is revealed by the above lists, will be seen to be essentially similar throughout. Further, with one exception (*Lysiosquilla biminensis*), all the known species are already recorded from the Indo-Pacific region.

It is interesting to notice that in several instances species on our roll are also represented in the West Indies, either by forms so far as is known identical with those from the Pacific, or by slightly different species or varieties.

The following is a list of such forms:—

<i>Indopacific form.</i>	<i>West Indian representative.</i>
1. <i>Gonodactylus chiragra</i> (Fabr.)	<i>G. oerstedii</i> Hansen ¹ .
2. <i>Pseudosquilla ciliata</i> (Fabr.)	<i>P. ciliata</i> , var. <i>occidentalis</i> nom. nov. ² .
3. <i>Lysiosquilla biminensis</i> , var. <i>pacificus</i> nov.	<i>L. biminensis</i> Bigelow.
4. <i>Stenopus hispidus</i> (Oliv.)	<i>S. hispidus</i> .
5. <i>Heterocarpus ensifer</i> A. M.-Edw.	<i>H. ensifer</i> .
6. <i>Panulirus penicillatus</i> (Oliv.)	<i>P. guttatus</i> (Fabr.) ³ .
7. <i>Petrolisthes lamarcki</i> (Leach)	<i>P. lamarcki</i> , var. <i>asiaticus</i> (Leach) ⁴ .

The following species in Dr Willey's collection occur also in sub-tropical Australia:—

1. *Protosquilla trispinosa* (Dana) [Swan River⁵].
2. *Gonodactylus chiragra* (Fabr.) [Swan River⁵].
3. *Penaeus canaliculatus* (Oliv.) [Port Jackson^{5, 6}].
4. *Alpheus laevis* Randall [Port Jackson⁵].
5. *Galathea australiensis* Stimps. [Port Jackson^{5, 6}].
6. *Pagurus deformis* H. M.-Edw. [Port Jackson⁶].
7. *Coenobita rugosus* H. M.-Edw. [Sydney⁵].
8. ? *Coenobita spinosus* H. M.-Edw. [Sydney⁶].

The following in New Zealand⁷:—

1. *Protosquilla trispinosa* (Dana).
2. *Palaemon lar* Fabr.
3. *Rhynchocinetes typus* H. M.-Edw.

¹ See below, under *G. chiragra*.

² See below, under *P. ciliata*.

³ Ortmann, Zool. Jahrb. vi. Syst. p. 29.

⁴ See P. Z. S., 1898, pp. 464—467. Var. *asiaticus* is also Indopacific.

⁵ Haswell, Cat. Austral. Crust., Sydney 1882.

⁶ Whitelegge, J. R. Soc. N.S.W. xxiii. pp. 224, 232.

⁷ Miers, Cat. N.Z. Crust. pp. 77, 87, 90.

Turning now to a systematic survey of the material, we may notice at the outset the relative extent to which the various groups of Macrura and Stomatopoda are represented.

There are seven species of Stomatopoda, belonging to six out of the nine genera of that order. Of these species one, a *Squilla*, is new. In the Macrura, the Penaeidea are represented by two species of *Penaeus*, the Stenopidea by one species of *Stenopus*, the Caridea by 32 species from 17 genera, the Loricata by 5 species from 3 genera, the Thalassinidea by three species from as many genera, and the Anomala by 32 species from 9 genera. The 19 new species in this suborder are distributed as follows: in the Caridea there are 13, in the Thalassinidea 2, in the Loricata one, and in the Anomala three.

Of the 38 genera in the whole collection, the most numerous represented is *Alpheus*, with six species; *Periclimenes*, on the other hand, has both absolutely and relatively¹ the largest number of new species (four out of five).

Conspicuous by their absence are the Astacidea and the Crangoninea.

SUB-CLASS. THORACOSTRACA.

ORDER. STOMATOPODA.

FAMILY. SQUILLIDAE.

GENUS. *Protosquilla*, Brooks, 1886.

1. *Protosquilla cerebralis* Brooks, 1886.

Protosquilla cerebralis Brooks, 'Challenger' Stomatopoda, p. 72, Pl. XIV. Figs. 2 and 3, XVI. Figs. 2 and 3 (1886); Borradaile, P. Z. S. 1898, Pl. V. Fig. 6a.

Brooks's specimens of *P. cerebralis* were all females. Fortunately, however, Dr Willey's collection contains a male specimen, so that it has been possible [P. Z. S. *loc. cit.*] to figure for this species the peculiar structure on the endopodite of the first abdominal appendage of male Stomatopoda.

The outer leaf of the last joint of this organ is smaller than the inner, on which it is borne as a lobe, and from which it is not sundered by a suture. The fixed limb of the pincers is hook-shaped, while the movable limb is bent sharply and of a shape something like that of a boomerang. The first joint is produced on the outside at the free end.

Two ♀ from Sandal Bay, Lifu, Loyalty Islands. One ♂ from Pigeon Island, New Britain.

¹ With the exception, of course, of the new genera *Palaemonopsis*, *Parhippolyte*, and *Alpheinus*, each founded for a single new species.

2. *Protosquilla trispinosa* (Dana), 1852.

Gonodactylus trispinosus, White, List Crust. Brit. Mus. p. 75 (1847) nom. nud.; Dana, Zool. U. S. Expl. Expd., Crust. I. p. 623 (1852); Miers, Cat. N. Zeal. Crust., p. 90; Ann. Mag. N. H. (5) v. p. 121, Pl. III. Fig. 10 (1880); Haswell, Cat. Austral. Crust., p. 211 (1882).

Protosquilla trispinosa Brooks, Challenger Stomatopoda, p. 71 (1886); Borradaile, P. Z. S., 1898, p. 34, Pl. V. Figs. 1, 1a (1898).

The following is an amended diagnosis of this species:—

"A *Protosquilla* with the lateral spines of the rostrum nearly as long as the median; carapace with angles nearly rectangular, anterior more acute than posterior; fifth and eighth thoracic segments with the lateral margin subacute, sixth and seventh with the same somewhat square; first abdominal segment with one, second to fourth with two lateral sulci; fifth longitudinally corrugated; sixth with six tubercles bearing fine spinules, and clearly marked off from the telson; the latter with a median and two lateral large tubercles covered with fine spinules, the median anterior to the two laterals, and with the posterior border divided by deep narrow fissures into six lobes; submedian, intermediate and lateral spines of the telson small and sunk in notches, several submedian spinules; outer spine of basal prolongation of uropod (6th abdominal limb) larger than inner, not armed with a tooth on its inner margin."

Length about 40 mm.

For figures see P. Z. S. 1898, Pl. V. Figs. 1, 1a.

1 ♀ from Lifu, Loyalty Islands.

GENUS. *Gonodactylus* Latr., 1825.3. *Gonodactylus chiragra* (Fabr.), 1793.

Squilla chiragra, Fabricius, Ent. Syst. III., 1, p. 513 (1793).

Gonodactylus chiragra Latreille, Encycl. Meth., x. p. 473 (1825); Miers, Ann. Mag. N. H. (5) v. p. 118 (1880); Haswell, Cat. Austral. Crust. p. 210 (1882); de Man, Zool. Jahrb. x. Syst. p. 694, Pl. XXXVIII. Fig. 77 (1898); Borradaile, P. Z. S. 1898, p. 34, Pls. V. Fig. 4, and VI. Fig. 8.

Gonodactylus smithii Pocock, Ann. Mag. N. H. (6) XI. p. 475, Pl. XX. B, Fig. 1 (1893).

De Man (*loc. cit.*) selects as the type of this species the form with the middle keel of the telson anchor-shaped. He further separates from it a variety which he names *acutirostris* and characterises as follows:—

1. Middle keel of telson not anchor-shaped.
2. Keels of submedian spines of telson converge from behind forwards.
3. Outer angles of rostrum acute.

There are in the present collection four specimens of a variety intermediate between the type and var. *acutirostris*. In these specimens the telson has not the anchor-

shaped middle keel; but neither are the outer angles of the rostrum sharp, and the keels of the submedian telson-spines do not converge forwards. Should a name for this variety be thought necessary, it is here proposed to call it var. *anancyrus*.

To these three varieties may be added that distinguished by Pocock in 1893 (*loc. cit.*) under the name of *G. smithii*, and characterised as follows¹:—

1. The keels of the sixth abdominal segment and telson are more compressed than in the type.

2. The keels of the sixth abdominal segment are produced, without constriction into long spines.

3. The upper edge of the middle keel of the telson is almost straight, and is produced backwards into a spine.

4. The 'flukes' of the anchor on the telson are represented by two narrow ridges running forwards from the hind end of the middle keel.

5. On each side of the first five abdominal tergites is a small, sharply-defined, dark spot.

Lastly, the *Gonodactylus oerstedii* of Hansen² may be considered in connection with the above forms, since it differs from them no more than they from one another, and rests its claim to specific rank mainly on its geographical distribution. It is characterised by the presence of a small swollen ridge on the inside of the keel of the intermediate spine of the telson, and in other respects resembles the type variety of *G. chiragra*. It is at present known only from the West Indies and east coast of America.

The distinguishing marks of the above forms may be set forth in key form as follows:—

1. Without a swollen ridge on the inside of the keel of the intermediate telson-spine. Distribution Indopacific.

2. Keels of sixth abdom. segment and telson rounded, not produced without constriction into spines. Middle keel of telson without a spine.

3. Middle keel of telson anchor-shaped.

VARIETY A. (type).

3'. Middle keel of telson not anchor-shaped.

4. Outer angles of rostrum not acute. Keels of submedian telson-spines not converging forwards.

VARIETY B. (*anancyrus*).

4'. Outer angles of rostrum acutely pointed. Keels of submedian telson-spines converging forwards.

VARIETY C. (*acutirostris*).

¹ P. Z. S., 1893, p. 34, where it is claimed that this form is but a variety of *G. chiragra*.

² Plankton-exped., Isop. Cum. u. Stom., p. 65. See also P. Z. S. *loc. cit.*, Pl. V., Fig. 3.

2'. Keels of sixth abdom. segment and telson compressed. Keels of sixth abdom. segment produced without constriction into long spines. Middle keel of telson ending in a spine.

VARIETY D. (*smithi*).

1'. With a swollen ridge on the inside of the keel of the intermediate telson-spine. Distribution Atlantic.

VARIETY (?) E. (*G. oerstedii* Hansen).

The specimens in the present collection include:—

i. Var. A. (type). 1 ♂ and 1 ♀ from the Isle of Pines, New Caledonia; 2 ♂ and 3 ♀ from Lifu, Loyalty Islands; 1 ♀ from Talili Bay, New Britain; 1 ♀ from Ralun, New Britain.

ii. Var. B. (*anancyrus*). 1 ♂ from Talili Bay; 2 ♀ from Lifu; 1 ♂ loc.?

iii. Var. D. (*smithi*). 2 ♂ and 2 ♀ from Lifu.

GENUS. *Odontodactylus* Bigelow, 1895.

4. *Odontodactylus scyllarus* (Linn.), 1758.

For references see P. Z. S. 1898, p. 36.

1 ♀ from New Britain.

GENUS. *Pseudosquilla* Dana, 1852.

5. *Pseudosquilla ciliata* (Fabr.), 1793.

Squilla ciliata, Fabricius, Ent. Syst. III., 1, p. 512 (1793).

Pseudosquilla ciliata, Miers, Ann. Mag. N. H. (5) V. p. 108 (1880); Brooks, 'Challenger' Stomatopoda, p. 53, Pl. XV. Fig. 10 (1886); Borradaile, P. Z. S. 1898, p. 36.

The present specimens agree with that of Brooks from Honolulu and that brought by Mr Gardiner from Funafuti (P. Z. S. *loc. cit.*) in the following points in which they differ from Brooks's West Indian specimens.

1. The fourth abdominal segment has no spine at the hinder angle.

2. The inner spine of the basal prolongation of the uropod is longer than the outer.

Should these differences prove to be characteristic of the forms from the two regions the name of var. *occidentalis* would be a suitable one to apply to that from the West Indies.

1 ♀ from Uvea, Loyalty Islands. 1 ♂ from Blanche Bay, New Britain.

GENUS. *Lysiosquilla* Dana, 1852.6. *Lysiosquilla biminiensis* Bigelow, 1893, var. *pacificus* nov.

Lysiosquilla biminiensis Bigelow, Joh. Hop. Univ. Circ. CVI., p. 102 (1893); Proc. U. S. Nat. Mus. XVII. p. 504, Figs. 4—7 (1895).

A single male specimen from New Britain seems to belong to a variety of this species. The resemblance to Bigelow's figures and description is complete save in the following small points:—

1. The movable submedian spines of the telson are stouter than in Bigelow's figure, while the innermost pair of submedian spinules are minute.

2. The outer spine on the basal prolongation of the uropod is slightly longer than it is figured for the type.

3. The antennal scales are somewhat smaller.

4. In addition to the markings shown by Bigelow there is a narrow band of deep black (in spirit) on the hinder edge of each segment from the sixth thoracic to the fifth abdominal inclusive.

These differences do not seem sufficient to justify the separation of the form in question from the West Indian species, and it is accordingly proposed to call it var. *pacificus*, emphasizing thereby its interesting distribution. *L. biminiensis* is the only species in the collection already known and not recorded from the Indopacific region, and forms one of the list already given to illustrate the coincidences between the Macruran and Stomatopodan fauna of the West Indies and that of the South Sea Islands visited by Dr Willey.

GENUS. *Squilla* Fabr., 1793.7. *Squilla multituberculata* Borradaile, 1898.

Squilla multituberculata, Borradaile, P. Z. S. 1898 p. 38, Pl. VI. Fig. 7, 7a—7c.

The short diagnosis accompanying the figures of this species in the above-mentioned paper may be here amplified with certain further details.

The *rostrum* is sub-rectangular, somewhat narrower behind than before, without carinae, and with the antero-lateral angles produced, bent downwards, and acute.

The *eyes* are elongate and flattened from above downwards, and their cornea consists of two roughly hemispherical portions set side by side on the end of the stalk.

The *carapace* is small, narrower before than behind, with rounded angles and the hinder border somewhat concave. The sides of the fifth thoracic segment are sharp, those of the sixth to eighth subtruncate.

The *antennae* have long stalks, and the last joint of the scale of the second pair is small.

In the *great claw* the last joint is stout, bearing on the inside four teeth (including the terminal tooth), and on the outside three short teeth at the base.

The *tail fin*. The sixth abdominal segment bears eight roughly longitudinal ridges and a few scattered knobs. It has two small blunt processes on the hinder edge, and

is sharply marked off from the telson. The latter is rather strongly convex, and is covered with small blunt spines. Along the middle line runs a raised ridge, grooved above. The marginal spines are small, and can hardly be seen from above. The sub-medians have a movable tip. There are four or five submedian spinules and five or six lateral. The uropod has a large basal joint, with the outer of the two spines on its prolongation obsolescent. The two joints of the exopodite are subequal, the first bearing eight spines on the outside. The endopodite is shorter than the exopodite. The latter equals the telson.

In the male the basal joint of the endopodite of the *first abdominal appendage* is broad and armed with long stout hairs. The inner leaf of the end-joint is somewhat narrow. The outer leaf is narrow, and is shorter than the inner, behind which it is hidden¹. The limbs of the pincers are long and narrow.

1 ♂ and 2 ♀, from Sandal Bay, Lifu, Loyalty Islands.

ORDER. DECAPODA.

SUB-ORDER. MACRURA.

TRIBE. PENAEIDEA.

FAMILY. PENAEIDAE.

GENUS. *Penaeus* Fabr., 1798.

8. *Penaeus fissurus* Bate, 1888.

Penaeus fissurus Bate, "Challenger," Macrura, p. 263, Pl. XXXVI., Fig. 1.

1 ♀ from Talili Bay, New Britain.

9. *Penaeus canaliculatus* (Oliv.), 1811.

Palaemon canaliculatus, Olivier, Encycl. Meth. VIII. p. 660 (1811).

Penaeus canaliculatus, H. M.-Edwards, H. N. Crust. II. p. 414 (1837); Bate "Challenger," Macrura, p. 243, Pl. XXXII. Figs. 1, 2 (1888).

1 ♂ from New Britain.

TRIBE. STENOPIDEA.

FAMILY. STENOPIDAE.

GENUS. *Stenopus* Latr., 1825.

10. *Stenopus hispidus* (Oliv.), 1811.

Palaemon hispidus, Olivier, Encycl. Meth. VIII. p. 666, Pl. XIX., Fig. 2 (1811).

Stenopus hispidus, Latreille, Desmarest's "Consid. s. l. Crust.," p. 227 (1825); Adams, Voy. 'Samarang,' p. 61 (1850); Herrick, Mem. Nat. Ac. Sci. v. 4, p. 348, Pls. V., XIII.

¹ Thus it is not shown in the figure given in the P. Z. S. *loc. cit.* The lobe underlying the movable limb of the pincers in this figure was drawn in error and does not exist.

The specimens agree with Herrick's description of the West Indian examples completely, even in the points in which the latter differ from Adams's figures.

2 ♂ and 1 ♀ from Blanche Bay, New Britain.

TRIBE. CARIDEA.

FAMILY. ATYIDAE.

GENUS. *Atya* Leach, 1817.

11. *Atya moluccensis* de Haan, 1849.

Atya moluccensis, de Haan, Faun. Japon., Crust., p. 186 (1849); Miers, Ann. Mag. N. H. (5) v. p. 382, Pl. XV., Figs. 3, 4 (1880); de Man, in Max Weber's "Zool. Ergebnisse," II. p. 357, Pl. XX., Fig. 20 (1892).

1 ♂ and 1 ♀ taken in a stream near Cape Gazelle, New Britain.

FAMILY. PONTONIIDAE.

Further particulars are now added to the preliminary diagnoses of certain species in this family already published by the author in the "Annals and Magazine of Natural History," 1898.

GENUS. *Periclimenes* Costa, 1844.

Periclimenes, Costa, Ann. Ac. Aspir. Nat. Nap. II. (1844); Faun. Regn. Nap. II. 1 (1846); Borradaile, Ann. Mag. N. H. (7) II. p. 380 (1898).

Pelias, Roux, Mem. s. l. Salicoques, p. 25 (1831) nom. praeoc.

Anchistia, Dana, U. S. Expl. Expd. Crust. 1. p. 577 (1852).

Dennisia, Norman, Ann. Mag. N. H. (3) VIII. p. 278 (1861).

The species described as *Pelias migratorius* by Heller in 1862 was afterwards placed by the same author in his new genus *Palaemonetes*, and recognised as identical with *P. varians* (Leach). It is therefore erroneously placed in the genus *Periclimenes* in the revision of that genus by the present writer (Ann. Mag. loc. cit.).

12. *Periclimenes spinigerus* (Ortm.), 1890.

Anchistia spinigera, Ortmann, Zool. Jahrb. v. Syst., 3, p. 511, Pl. XXXVI., Figs. 23, 23 a (1890).

Periclimenes spinigerus, Borradaile, Ann. Mag. N. H. (7) II. p. 383 (1898).

1 ♀ from Lifu, Loyalty Islands.

13. *Periclimenes lifuensis* Borradaile, 1898, Figs. 1a—1c¹.

Periclimenes lifuensis, Borradaile, Ann. Mag. N. H. (7) II. p. 384 (1898).

Carapace. The rostrum is straight, outreaches the antennal scale, and bears six teeth above but none below. The supraorbital and antennal spines are present, but not the hepatic. There is also a spine on the mid-dorsal line behind the rostrum. The pterygostomial angle is acute.

¹ This reference (and all similarly placed references) relates to the figures on Plates XXXVI.—XXXIX., the numbers of which run consecutively.

Antennae. The stalk of the first antenna is shorter than the scale of the second, and consists of a very broad first joint, projecting forwards and outwards in a sharp point at the distal end, and two short, subequal following joints. The inner flagellum is broken short on either side in the present specimen, and the thicker part of the outer outreaches the scale of the second antenna, though not the fringe of hairs on that structure. The stalk of the second antenna about equals that of the first in length.

The *third maxilliped* reaches the end of the stalk of the second antenna.

Legs (Pereiopoda). The first pair of legs has the beginning of its wrist-joint (*carpopodite*) even with the end of the second joint of the antennular stalk, and outreaches the scale of the second antenna by the hand (*propodite*) and the last two-thirds of the wrist. The fingers about equal the palm in length. The second pair are subequal. Their meropodite about reaches the end of the rostrum, the wrist is short and armed above with a spine, and the fingers are about two-thirds as long as the palm, hairy, and curved towards one another at the tip, thus enclosing a space. The remaining legs are short and stout, and their last joint is curved and arises among a tuft of long hairs.

Tail-fin. The uropods are longer than the telson, and their exopodite and endopodite are subequal.

Length of the single specimen 11 mm.

From the above characters it would seem to be necessary to place this species in the neighbourhood of *P. gracilis* (Dana) 1852, from which, however, it is sundered by the presence of a supraorbital spine, to mention only one point of difference.

Lifu, Loyalty Islands.

14. *Periclimenes tenuipes* Borradaile, 1898, Figs. 2a—2f.

Periclimenes tenuipes, Borradaile, Ann. Mag. N. H. (7) II. p. 384 (1898).

Carapace. The rostrum is long, slender, curved upwards, armed above with ten teeth (of which the first two stand on the carapace) and below with seven, and outreaches the antennal scale, but not the outer antennular flagellum. Hepatic and antennal spines are present, and the pterygostomial angle is rounded.

All the appendages are unusually slender and elongated.

Antennae. The stalk of the first antenna is shorter than the scale of the second. Both its flagella are long, the outer being bifid at the tip. The stalk of the second antenna does not reach the end of the first joint of that of the first. Its scale is longer than the antennular stalk, shorter than the rostrum, and narrow.

Mouth-limbs. These are shown in Figs. 2c—f. The third maxilliped nearly reaches the end of the first joint of the antennular stalk.

Legs. The first pair is wanting in the single specimen. The end of the meropodite of the second is even with the rostrum, and is armed beneath with a spine. The wrist is longer than the meropodite and slightly longer than the palm. It grows broader towards its outer end, where it is armed above with a spine. The movable finger bears three teeth on its inner edge. In the last three legs the propodite is armed with spines.

Tail-fin. The exopodite of the uropod is longer than the endopodite, and both are considerably longer than the telson. The latter structure is armed at its free end

with the usual six spines found in this position in the present family. These are, namely, two submedian, two intermediates longer than the submedian, and two laterals shorter than the submedian.

The single specimen measures 11 mm. in length, and was found on the reef at Ralun, New Britain.

The following two species are both of small size and have a certain immature appearance. They are here described and named provisionally.

15. *Periclimenes parvus* Borradaile, 1898, Figs. 3a—3c.

Periclimenes parvus, Borradaile, Ann. Mag. N. H. (7) II. p. 384 (1898).

Carapace. Rostrum slightly longer than antennular stalk, bent downwards at first, but tending to straighten towards the tip, above with a deep crest bearing six teeth, below with one tooth. Antennal and hepatic spines are present, and the pterygostomial angle is subrectangular.

Antennae. The stalk of the first antenna is shorter than the scale of the second. The stalk of the second antenna does not reach the end of the first joint of the antennular stalk; the scale is outreached by the antennular flagella.

The *eyes* are large.

The *third maxilliped* is shown in Fig. 3c; it is rather small, barely reaching the end of the peduncle of the second antenna.

The legs. The first pair of legs are short, not outreaching the antennal scale, and fairly stout. The second pair are short, simple in form, without spines, and outreach the antennal scale by about the latter half of the meropodite. The longest joint is the hand. The remaining legs are slender, and have nearly straight, biunguiculate dactyles.

The tail-fin. The exopodite of the uropod is longer than the endopodite, and both are longer than the telson. The latter bears at its hind end two very strong spines and four weaker ones.

Two specimens, 8.5 mm. long, were taken at Rakaiya, Blanche Bay, New Britain.

16. *Periclimenes parasiticus* Borradaile, 1898, Figs. 4a—4b.

Periclimenes parasiticus, Borradaile, Ann. Mag. N. H. (7) II. p. 384 (1898).

Carapace. The rostrum is straight, with a large convex dorsal crest of seven teeth, but unarmed below. It just outreaches the first joint of the antennular stalk. Antennal spines are present, but not supraorbital.

The *eyes* are large.

Antennae. The stalk of the first antenna is shorter than the scale of the second. The stalk of the second is not so long as the basal joint of the first. The scale of the second antenna is broad and reaches the end of the thicker antennular flagellum.

The *third maxilliped* barely reaches the pterygostomial angle of the carapace.

Legs. First pair short, strong, and with unusually stout hands. Second pair small with short wrist, and without spines on any of the joints.

The sixth abdominal segment is considerably elongated.

Tail-fin. The exopodite of the uropod is longer than the endopodite. This, in turn, is longer than the telson.

Length of largest specimen 7 mm.

Four specimens of this species were found living among the spines on the back of a black starfish of the genus *Linckia*.

GENUS. *Anchistus*, Borradaile, 1898.

17. *Anchistus miersi* (de Man), 1888.

Harpilius Miersi, de Man, Journ. Linn. Soc., Zool. XXII. p. 274, Pl. XXII. Figs. 6—10 (1888).

Anchistus miersi, Borradaile, Ann. Mag. N. H. (7) II. p. 387 (1898).

2 ♀ and 1 ♂, found in the mantle-chamber of a *Tridacna squamosa* at Dobu, D'Entrecasteaux Group, British New Guinea.

18. *Anchistus biunguiculatus* Borradaile, 1898, Figs. 5a—5c.

Anchistus biunguiculatus, Borradaile, Ann. Mag. N. H. (7), II. p. 387 (1898).

Carapace. The rostrum reaches the end of the first joint of the antennular stalk, is strongly curved downwards, and bears no teeth. The antennal spine alone is present, and the pterygostomial angle is rounded.

Antennae. The stalk of the first antenna does not quite reach the end of the scale of the second. The flagella are subequal and of moderate length only. The stalk of the second antenna is as long as the basal joint of the first, and the scale is broad.

Mouth-limbs. These have not been examined in the single specimen. The third maxilliped reaches half way up the last joint of the second antennal stalk.

Legs. The first pair of legs outreach the antennal scale by the last half of the wrist and the hand. The second pair are equal, symmetrical, and without spines on any of their joints. The hand is long and rather narrow. The wrist is half the length of the palm. The fingers are unequal, the movable one being considerably longer than the immovable and hooked at the end. The immovable finger is more than half as long as the palm.

Tail-fin. The exopodite of the uropod is slightly longer than the endopodite. The latter is somewhat longer than the telson, which is triangular, with a rounded apex bearing the usual six spines.

Length 50 mm.

One ♀ from a *Tridacna*, in Tubetube, Engineer Group, British New Guinea.

GENUS. *Coralliocaris* Stimpson, 1860.

19. *Coralliocaris inaequalis*, Ortmann, 1890.

Coralliocaris inaequalis, Ortmann, Zool. Jahrb. v. syst. 3, p. 510, Pl. XXXVI. Figs. 21, 21d—i (1890).

3 specimens from Sandal Bay, Lifu, Loyalty Islands.

GENUS. *Pontonia* Latr. 1829.

20. *Pontonia ascidicola* Borradaile, 1898, Figs. 6a—6b.

Pontonia ascidicola, Borradaile, Ann. Mag. N. H. (7) II. p. 389 (1898).

Carapace. Rostrum short, reaching only half way up the first joint of the antennular stalk. The free end is strongly curved downwards and lacks an inferior keel. The antennal spine alone is present and the pterygostomial angle is rounded.

Antennae. The stalks of the two pairs of antennae and the scale of the second are subequal. The scale is broad and of but moderate length.

Mouth-limbs. These have not been dissected out. The third maxilliped ends opposite the second joint of the antennular stalk (Fig. 6b).

Legs. The first pair of legs are rather unusually strong. Their meropodite reaches the end of the first joint of the antennular stalk. The wrist is a little shorter than the meropodite and the hand a little shorter than the wrist. The fingers are as long as the palm. The second pair are unequal. In the larger, the hand is of great size, the fingers half the length of the palm, the wrist short and stout, the meropodite longer than the wrist, the movable finger bearing one tooth and the immovable finger two. In the smaller leg of the second pair, the hand is still the longest joint, the movable finger is narrow and crosses its fellow at the tip, and both are provided with teeth as in the longer hand. In the female both legs of the second pair are relatively shorter than in the male. The dactyles of the remaining legs are short, fairly stout, and provided with several spines underneath.

The abdominal pleurae are greatly developed in the female.

Tail-fin. The two rami of the uropod are subequal in the male. In the female the endopodite is the longer. In each case the telson is as long as the exopodite, and bears the usual six spines at the free end.

The *length* is 13 mm.

1 ♂ and 1 ♀ from Blanche Bay, New Britain.

GENUS. *Conchodytes* Peters, 1851.

21. *Conchodytes meleagrinae* Peters, 1851.

For references see P. Z. S. 1898, p. 1007.

3 ♀, from Sandal Bay, Lifu, Loyalty Islands, and from Engineer Group and Conflict Group, British New Guinea, respectively.

FAMILY. PALAEMONIDAE.

GENUS. *Palaemon* Fabr., 1798.

22. *Palaemon lar* Fabr., 1798.

For references see P. Z. S. 1898, p. 1008.

4 ♂ of various ages, taken near Cape Gazelle, New Britain.

23. *Palaemon weberi* de Man, 1892.

Palaemon weberi, de Man, in Max Weber's "Zool. Ergebnisse," II. p. 421, Pl. XXV. Fig. 23 (1892).

One young male (55 mm.), agreeing closely with de Man's description of a similar specimen from the East Indies, was taken in a stream near Schultze Point, New Britain. In both chelae, however, the fingers are shorter than the palm, while the whole body is smooth, neither carapace nor telson being "körnig rauh."

GENUS. *Leander* Desmarest, 1840.24. *Leander pacificus* Stimpson, 1860.

Leander pacificus, Stimpson, Proc. Ac. N. Sci. Philad. 1860, p. 40.

The fifth pair of legs in the single specimen seem somewhat longer than is indicated by Stimpson's description.

Locality, Isle of Pines.

GENUS. *Palaemonopsis* nov.

There is in the collection a solitary Palaemonid for which it seems to be necessary to found a new genus. The specimen in question differs from the members of the genus *Palaemon* in the absence of a mandibular palp. From *Palaemonetes* it differs in having on each side of the carapace one antennal spine only, and, directly behind the eye, at a short distance from the edge of the carapace, a large, blunt, roughly triangular process. About half of the thicker branch of the outer flagellum of the first antenna is fused with the thinner branch, but the two branches are quite distinctly formed down to their bases, so that the genus must be placed in the present family rather than in the *Pontoniidae*. The slenderness of the third maxilliped points to the same conclusion.

25. *Palaemonopsis willeyi* sp. n., Pl. XXXVI.—XXXVII., Figs. 7a—7e.

Diagnosis:—"A *Palaemonopsis* with the rostrum straight, bearing six equal teeth above and four teeth below, outreaching the antennular stalk but not the antennal scale; carapace bearing a single antennal spine on each side, and a large triangular process behind the eye; pterygostomial angle subrectangular; first antenna with last two joints of the stalk together shorter than first joint, and subequal; flagella unequal, the outer larger and with its two branches fused for about half the length of the thicker branch; second antenna with the stalk equal to the first two joints of the antennular stalk, the scale longer than the rostrum, narrowing to the free end, which is truncated and bears a triangular tooth, projecting beyond it, on the outside; third maxilliped small and slender; first pair of legs reaching the end of the antennal scale, with wrist and meropodite subequal and longer than the hand; second pair large, strong, longer by the hand than the antennal scale, with short, stout wrist, and meropodite a little longer than the palm, the fingers longer than the palm, crossing at the tip and serrate, none of the joints with spines; remaining legs fairly stout, with small, straight, slender

dactyles, third longer than fourth or fifth; sixth abdominal tergite with a broad triangular median backward projection, flanked on each side by a spine; endopodite of the uropod very slightly longer than the telson, exopodite slightly larger than endopodite; telson elongate, narrowing gently towards the free end, which is truncate, bearing on each side a short, strong spine, and in the middle a tuft of hairs, dorsal surface with four pairs of movable spines."

Length 30 mm.

1 specimen from Ralun, New Britain.

FAMILY. PANDALIDAE.

GENUS. *Pandalus* Leach, 1814.

Into this genus Ortmann has reunited the genera *Plesionika*, *Nothocaris*, and *Pandalopsis* of Bate. Three species of *Pandalidae* from New Britain have certain characters in common which appear to justify the foundation for them of a new subgenus equivalent to the above-mentioned groups of species.

SUBGENUS. *Parapandalus* nov.

Characters:—

1. Carapace without lateral carinae.
2. Rostrum long, slender, armed above and below with movable spines.
3. First antenna with long flagella and pointed stylocerite.
4. Hinder lobe of scaphognathite truncated.
5. Third maxilliped with an exopodite.
6. First leg subchelate¹ owing to a small projection of the propodite at the base of the finger.
7. Second pair of legs equal, with 25—30 joints in the wrist.
8. Eye with large cornea, well-marked ocellus, and two-jointed stalk.
9. Gill formula as in *Pandalus* (sens. str.), save that in two of the species epipodites are wanting behind the third maxilliped.

26. *Pandalus* (*Parapandalus*) *serratifrons* sp. n., Figs. 8a—8d.

Diagnosis:—"A *Pandalus* with the rostrum long, outreaching the antennal scale, armed above and below with numerous small, similar, movable spines, of which the

¹ The word subchelate hardly describes the structures in question satisfactorily. The impression is not that of a practicable grasping organ. Reference to fig. 8d will make this clear. For some interesting remarks on the subject of this limb in *Pandalus* see Calman, Ann. Mag. N. H. (7) III. p. 27 (1899).

first four or five are on the carapace; carapace with antennal spine, acute pterygostomial angle, and a small dorsal carina on the anterior third of its length; eyes fairly large, with ocellus distinct, but not completely separated from main cornea; all the appendages long and slender; first antenna with relatively short stalk, first joint longer than second and third together, third longer than second, both flagella long, outer broad and flattened at the base and bearing in this region a fringe; stylocerite as long as first joint and ending in a sharp point; second antenna with the stalk short, equal to the first joint of the antennular stalk; scale elongate, narrowing to the free end, where it is truncated, with firm outer edge ending in a spine which starts before the end of the scale and projects beyond it; third maxilliped longer by its last two joints than the antennal scale; epipodites wanting behind the third maxilliped; legs of the first pair longer by their last two joints than the third maxilliped; legs of the second pair equal, exceeding the antennal scale by the hand and the last two or three joints of the wrist, the wrist about 25-jointed, with the last joint nearly equal to three of the preceding joints, growing broader towards the hand; hand arising in a tuft of hairs and with long hairs on the fingers; remaining legs long and slender, with movable spines on the meropodite and the dactyle small; uropod with exopodite larger than endopodite, endopodite longer than telson; telson long, very narrow, with four spines at the end, and four pairs of spines on the dorsal surface."

Length of largest specimen 85 mm.

This species forms part of the food of the *Nautilus*.

7 ♂, trawled at depths of 50—100 fathoms in Blanche Bay, New Britain.

27. *Pandalus* (*Parapandalus*) *tenuipes* sp. n., Fig. 9.

Diagnosis:—"A *Pandalus* with the rostrum long, outreaching the antennal scale, bent slightly upwards, armed above and below with numerous small, similar, movable spines, of which the first four or five are on the carapace; carapace with antennal and small pterygostomial spine and a slight dorsal carina on the first half of its length; eyes fairly large and ocellus distinct, but not completely separated from the cornea; all the appendages very long and slender; first antenna with rather short stalk, the first joint longer than the second and third together, the third longer than the second, both flagella long, the outer broad and flattened at the base, where it bears a fringe; stylocerite acute; second antenna with the stalk short, and the scale longer than the antennular stalk, with firm outer edge ending in a spine which arises before the end of the scale and just projects beyond it; third maxilliped considerably longer than the antennal scale, with fairly stout meropodite, and the rest of the limb very weak and slender; no epipodite behind the third maxilliped; first pair of legs considerably longer than the rostrum; second pair of legs longer than the antennal scale by the last half of its wrist; the latter about 30-jointed, with the last joint equal to two or three of the preceding joints; last three legs with the meropodite fairly strong and armed with spines, and the distal part of the limb very long and weak; exopodite of uropod longer than endopodite and armed with a spine on the outside near the free end; endopodite

longer than telson; telson armed with four pairs of spines above, and with two pairs at the free end."

2 ♀ from Blanche Bay, New Britain. 2 ♂ from the D'Entrecasteaux Group, British New Guinea.

28. *Pandalus (Parapandalus) longirostris* sp. n., Figs. 10a—10h.

Diagnosis:—"A *Pandalus* with the rostrum long, outreaching the antennal scale, bent upwards and armed above and below with movable spines, those at the base above being longer and farther apart than those towards the free end, and the first three or four being placed on the carapace; carapace with antennal spine, a spine at the pterygostomial angle, and a keel on the anterior half of its dorsal surface; eyes fairly large, with ocellus distinct but not completely sundered from the main cornea; appendages moderately stout; first antenna with the basal joint of the stalk longer than the second and third together, third rather longer than second, second covered with hairs, stylocerite longer than basal joint and ending in a spine, both flagella long, outer broad and flat at base, in which region it bears a fringe of hairs; second antenna with short stalk and long scale, whose external tooth barely projects at the end; third maxilliped slightly longer than the antennal scale; epipodite wanting from the last leg only; first pair of legs very little longer than third maxillipeds; second pair of legs equal, with about 25 joints in the wrist; uropod longer than the telson, which is narrow, elongated, and armed at the end with one median and four movable lateral spines, and bears four pairs of spines on the dorsal surface."

Length 130 mm.

4 ♀ from New Britain, 2 with eggs.

GENUS. *Heterocarpus* A. M.-Edw., 1881.

29. *Heterocarpus ensifer* A. M.-Edw., 1881.

Heterocarpus ensifer, A. M.-Edw., Ann. Sci. Nat. (6) XI. 4 p. 8 (1881); Bate, "Challenger" Macrura, p. 638 pl. CXII. fig. 4 (1888).

In the present specimen the spines on the rostrum vary from 12 to 16 above, and from 7 to 10 below.

The first leg is simple. In *H. gibbosus* Bate it is chelate (Calman, *loc. cit.*)

3 ♀ and 2 ♂ from Blanche Bay, New Britain. 4 young specimens from the same locality in 100 fathoms of water.

FAMILY. HIPPOLYTIDAE.

GENUS. *Saron* Thallw., 1891.

30. *Saron marmoratus* (Oliv.). 1811.

See P. Z. S. 1898, p. 1009 (1899).

1 ♀ from Nivani, Louisiades, British New Guinea.

FAMILY. LATREUTIDAE.

GENUS. *Parhippolyte* nov.

The absence of a cutting edge (*psalistema*) from the mandible of the species on which this new genus is founded obliges me to place it in Ortmann's new family, Latreutidae. [Bronn's "Thierreich," Crust. II. p. 1130 (1898).] It is, however, so closely allied to *Merhippolyte* Bate that it might almost equally well be placed like the latter group as a subgenus of *Spirontocaris* Bate (non *Hippolyte* Leach, restrict.). In any case, the difference between the Latreutidae and Hippolytidae will not, I think, be ultimately found to be of more than subfamily value.

Characters of *Parhippolyte* n. gen.

1. Rostrum moderate, dentate.
2. Supraorbital spine wanting, antennal and postorbital spines present.
3. Flagella of first antenna long.
4. Mandible without cutting edge, with three-jointed palp.
5. Third maxilliped with exopodite.
6. Second wrist multiarticulate (about 30 joints).
7. Branchial formula as in *Merhippolyte* but no pleurobranch on third maxilliped.
8. Sixth abdominal segment with the hinder angle provided with a small spine, but not articulated.

31. *Parhippolyte uveae* n. sp., Figs. 11a—11g.

Diagnosis:—"A *Parhippolyte* with the rostrum, bearing three or four teeth above and five below; with antennal and postorbital spines present, the pterygostomial angle of the carapace rounded and the anterior two-thirds dorsally carinated; the antennular stalk half the length of the antennal scale, its first joint almost equal to the second and third together, the stylocerite equal to the first joint, broad, acute, the flagella subequal; the scale of the second antenna long, broad at the base, narrowing rapidly, with the spine barely projecting beyond the free end, flagellum about equal to the antennular flagella; third maxilliped outreaching the antennal scale by the last two-thirds of its last joint, which is obliquely truncated at the end; first leg not reaching the end of the antennal scale, hand equal to wrist, fingers shorter than palm, not dentate, with a small black claw at the tip; second leg outreaching by the wrist the antennal scale, wrist about 30-jointed, first and last joints subequal, about twice the length of any of the others; remaining legs long, the last slightly the longest, owing to increased length of the propodite, meropodite with spines underneath; endopodite of uropod as long as telson, exopodite longer; telson ending in a median spine and bearing at the end four lateral spines and on the dorsal surface four pairs of spines."

Length 110 mm.

Ten specimens, ? all female. Three with eggs. From Uvea, Loyalty Islands.

FAMILY. RHYNCHOCINETIDAE.

GENUS. *Rhynchocinetes* H. M.-Edw., 1837.32. *Rhynchocinetes typus* H. M.-Edw., 1837.*Rhynchocinetes typus*, H. Milne-Edwards, Ann. Sci. Nat. 2 VII. p. 165, pl. iv. C. (1837).

The single specimen, which is from Lifu, Loyalty Islands, has on the rostrum only four spines above and only twelve below.

FAMILY. ALPHEIDAE.

GENUS. *Alpheinus* nov.

The recent work of Coutière [Bull. Mus. Paris, II. p. 380 (1896)] on this family necessitates the establishment of a new genus as well as of a new species for two specimens of an Alpheid from Lifu.

Characters of *Alpheinus* n. gen.

1. Eyes completely covered above but not enclosed in front.
2. Rostrum and ocular spines present.
3. Eyestalks short, without spines above. Cornea lateral.
4. Outer flagellum of first antenna slightly bifid at tip.
5. Pleurobranch to each leg. Arthrobranch to third maxilliped. No epipodites.
6. First pair of legs unequal. Left like the large leg of *Alpheus*, but with movable finger as in *Betaeus*. Right small, simple.
7. Angle of sixth abdominal segment not articulated.

33. *Alpheinus tridens* n. sp., Figs. 12a—12g.

Diagnosis:—"An *Alpheinus* with the rostrum of moderate length, shorter than the first joint of the antennular stalk, triangular with a sharp apex, depressed at base, compressed at apex, not dentate, with a dorsal keel starting between the eyes; ocular spines resembling rostrum but shorter; carapace without other spines than the ocular and with produced but not acute pterygostomial angle; first antenna with the stalk longer than the antennal scale, first joint longer than second and third together, second longer than third, first two joints projecting on the outside at the distal end and bearing on the projection a few strong plumose hairs; stylocerite sharp, almost equal to the first joint; second antenna with the scale shorter and the stalk longer than the stalk of the first antenna, scale with strong outer border and freely projecting spine, basipodite with stout spine on the outer side; third maxilliped very hairy, reaching the end of the antennal scale; larger leg of the first pair outreaching the antennal scale by the last two-thirds of the palm, hand longer than carapace, fingers shorter than palm, a spine on the palm at the base of the movable finger, and a tooth

on the biting edge of the same finger, wrist very short with a spine on the outer and another on the inner side, meropodite shorter than the palm, with a spine on the outer side at the distal end; smaller leg of the first pair longer than the antennal scale, simple, hairy, with hand long and wrist short, and fingers shorter than the palm; second leg outreaching the antennal scale by the last four joints of the wrist, wrist 5-jointed, $1 = 2 + 3 + 4 + 5$, $5 = 3 + 4$, 2, 3, 4 subequal; remaining legs rather stout, propodite longer than carpopodite, shorter than meropodite, carpopodite with one tooth above at the distal end, dactyle stout, biunguiculate, numerous spines underneath the propodite; telson and uropods short and broad; endopodite and exopodite of uropod subequal, somewhat longer than telson, exopod with first joint projecting considerably outside the second and bearing on the projection a slender spine; telson with the free end subtruncate, with a low rounded lobe in the middle, two short spines on each side and a long fringe, and with two pairs of movable spines on the dorsal surface."

Length 20 mm.

2 specimens from Sandal Bay, Lifu, Loyalty Islands.

GENUS. *Synalpheus* Bate, 1888.

Synalpheus, Bate, Challenger, Macrura, p. 572 (1888); Coutière, Notes, Leyd. Mus. XIX. p. 206 (1897).

34. *Synalpheus biunguiculatus* (Stimps.), 1860.

? *Alpheus biunguiculatus*, Stimpson, Proc. Ac. N. Sci. Philad. 1860, p. 31.

Alpheus minor, var. *biunguiculatus*, de Man, J. Linn. Soc. Zool., xxii. p. 273 (1888).

Alpheus sp., de Man, Zool. Jahrb. ix. Syst. p. 738, Fig. 62 (1897).

? *Alpheus tricuspidatus*, Heller, Sitz. Ak. Wiss. Wien, XLIV. p. 267 (1861).

1 ♀ from the Reef, Ralun, New Britain.

Var. C, nov. One male, and a small specimen with a Bopyrid in the gill chamber, taken in the mantle cavity of an ascidian at Baravon, New Britain, differ from de Man's type in having the ocular spines as long as the rostrum and rather broad and triangular. De Man has named two varieties A and B respectively. I propose to call the present form var. C.

35. *Synalpheus demani* nom. nov.

Alpheus triunguiculatus, de Man, Arch. Naturg., LIII. 1, p. 508, Pl. XXII. Fig. 2 (1887).

According to Coutière the name *triunguiculatus* was given by Paulson in 1875 to a species which must be included in the genus *Synalpheus*. It is very unlikely that this species is identical with that to which de Man gave the same name in 1887, describing it as new. A new name is, therefore, probably wanted, and the most appropriate course is obviously to call the species after its first describer.

2 ♀ from Lifu, Loyalty Islands.

36. *Synalpheus neomeris* (de Man), 1897.

Alpheus neomeris, de Man, Zool. Jahrb. ix. Syst., p. 734 (1897).

One specimen, from Sandal Bay, Lifu, Loyalty Islands.

GENUS. *Alpheus* Fabr., 1778.

37. *Alpheus obesomanus* Dana, 1852.

Alpheus obesomanus Dana, U.S. Expl. Exped. Crust. i. p. 574, Pl. XXXIV. Fig. 7 (1852).

Two specimens from Lifu, Loyalty Islands. One from Blanche Bay, New Britain.

38. *Alpheus gracilidigitus* Miers, 1884, var.

Alpheus gracilidigitus Miers, "Alert" Report, p. 287 (1884); de Man, Max Weber's Zool. Ergebnisse, p. 406, Pl. XXV. Fig. 32 (1892).

The specimens differ from the type in that:—

1. The lower border of the merus of the first leg is not serrate.
2. The movable finger of the small chela wants the tooth on the inner side.

One ♂ and one ♀ from the Isle of Pines, New Caledonia.

39. *Alpheus laevis* Randall, 1839.

For references see P. Z. S. 1898, p. 1013.

2 ♀ from Blanche Bay, New Britain. 1 ♀ from Sandal Bay, Lifu.

40. ? *Alpheus diadema* Dana, 1852.

? *Alpheus diadema* Dana, U.S. Expl. Exped. Crust. i. p. 555, Pl. XXXV. Fig. 7 *a—e* (1852).

Dana describes the first joint of the wrist of the second pair of legs as being "much longer than the second," but figures it as of almost the same length. In the present specimen it is very slightly shorter. The hands of the first pair, which were wanting, from Dana's specimen, are figured from that in the present collection (Pl. XXXIX., Fig. 17).

1 ♀ from Sandal Bay, Lifu, Loyalty Islands.

41. *Alpheus frontalis* Say. 1832.

For references see P. Z. S., 1898, p. 1013.

2 ♂ and 1 ♀ from Lifu, Loyalty Islands.

42. *Alpheus aglaopheniae* n. sp., Figs. 13*a—13f*.

A single, dismembered specimen of an *Alpheus* found living among the branches of a hydroid polyp of the genus *Aglaophenia*, represents, I think, a new species. It is diagnosed as follows:

"An *Alpheus* with the rostrum arising from the anterior border of the carapace, reaching the end of the first joint of the antennal stalk, and continued backwards as a short keel on the carapace; eye-hoods acute in front; second and third joints of the

antennular stalk subequal, first joint somewhat longer than either, stylocerite equal to the first joint; stalk of second antenna longer than that of the first, scale bearing a strong spine, equal to the antennular stalk, long fringed; third maxilliped large, covered with long hairs, projecting beyond the antennular stalk; larger leg of the first pair with the lower border notched but the upper only very faintly so, fingers less than half the length of the palm, wrist short, somewhat excavated, meropodite broad, with large distal spine and distal end excavated, hand hairy; smaller leg of the first pair with hand elongate, bearing a spine above the movable finger, hairy, fingers equal to the palm, wrist short, with a spine on the outside, meropodite of the same form as in the larger hand, but with the spine smaller and the distal end excavate; second pair of legs with the first joint of the wrist the longest, 2 and 5 equal, 3 and 4 short, hand about equal to first wrist-joint; remaining legs without a spine on the meropodite, the propodite armed with spines, the dactyle biunguiculate, one-third the length of the propodite; the exopodite of the uropod larger than the endopodite, the latter larger than the telson, which is hairy above."

Length 11.5 mm.

One ♀ from the Engineer Group, British New Guinea.

TRIBE. LORICATA.

FAMILY. PALINURIDAE.

GENUS. *Panulirus* White, 1847.

43. *Panulirus demani* nom. nov.

Panulirus polyphagus, Ortmann, in Semon's "Forschungsreisen in Austral.," v. 1, p. 19 (1894).

Panulirus sp., de Man, Zool. Jahrb. IX. Syst. p. 507 (1898).

There is no evidence for the view that this is a young form of *P. polyphagus*, and it is therefore well that it should receive at least a provisional name. It is here proposed to call the species *Panulirus demani* after the author who first recognised its distinctness.

One ♂, from Blanche Bay, New Britain.

44. *Panulirus bispinosus* sp. n.

A small specimen in the collection seems to deserve a name and a short diagnosis as a probably new species. It bears a considerable resemblance to *P. femoristriga* v. Martens, 1872, of which it may possibly be a young example, but the abdominal furrows are interrupted in the middle line, and the antennal tergite is quite smooth, save for two spines towards the anterior edge. *P. femoristriga* probably also occurs in the Loyalty Islands, since Dr Willey took, but did not preserve, a large Palinurid which from his description would seem to belong to that species.

Diagnosis:—"A *Panulirus* with the stalk of the first antenna somewhat shorter than that of the second, the first joint longer than the second or third, the third some-

what longer than the second; the carapace and the stalk of the second antenna covered with spines of various sizes with their points directed forwards, somewhat sparsely mingled with hairs; the antennal segment bearing two spines only and no spinules; the third maxilliped with an exopodite bearing a flagellum which reaches half way up the mero-podite; the legs hairy, the second pair the longest; the abdominal furrows interrupted in the middle line of the body."

Length 25 mm.

One ♂ from Sandal Bay, Lifu, Loyalty Islands.

45. *Panulirus penicillatus* (Oliv.) 1811.

For references see P. Z. S., 1898, p. 1015.

One ♂ from Natikitiwan, Lifu, Loyalty Islands.

FAMILY. SCYLLARIDAE.

GENUS. *Scyllarus* Fabr., 1793.

46. *Scyllarus sieboldi* de Haan, 1850.

Scyllarus sieboldi, de Haan, Faun. Japon. Crust., p. 152, Pl. XXXVI. Fig. 2 (1850).

1 ♂, 1 ♀ from Lifu, Loyalty Islands.

GENUS. *Paribacus* Dana, 1852.

47. *Paribacus antarcticus* (Rumph).

For references see P. Z. S., 1898, p. 1015.

5 ♂, 2 ♀, from Natikitiwan, Lifu, Loyalty Islands.

TRIBE. THALASSINIDEA.

FAMILY. CALLIANASSIDAE.

GENUS. *Callianassa* Leach, 1814.

48. *Callianassa novae-britanniae* sp. n., Figs. 14a—14d.

Diagnosis:—"A *Callianassa* with the rostrum short, triangular, not half the length of the eyestalks; the latter compressed, not quite equal to the first joint of the antennular stalk, with lateral cornea; carapace with a triangular projection between the eye and the base of the second antenna, and the pterygostomial region projecting forwards below the antenna, a well-marked median ridge and cervical furrow, and the hinder border excavate; first antenna having the second joint of the stalk the longest and the whole stalk shorter than that of the second antenna; last joint of third maxilliped broad and with a long fringe of hairs, other joints all fairly broad; first pair of legs unequal, wrist as broad as hand, fingers shorter than palm, moveable fingers longer than

immovable, meropodite armed with spines; telson short, broader than long, with straight hinder edge; uropod longer than telson, with the raised portion of the exopodite not projecting laterally beyond the rest of the structure.

Length 37 mm.

1 ♂, from New Britain.

GENUS. *Callianidea* H. M.-Edw., 1837.

49. *Callianidea typa*, H. M.-Edw., 1837.

Callianidea typa, H. M.-Edw., H. N. Crust. II. p. 320, Pl. XXV. *bis*, Figs. 8—14 (1837).

1 ♂ from Sariba, British New Guinea.

FAMILY. AXIIDAE.

GENUS. *Eiconaxius* Bate, 1888.

50. *Eiconaxius taliliensis* sp. n., Figs. 15a—15c.

Diagnosis:—"An *Eiconaxius* with the rostrum equal to the first joint of the antennular stalk, ending in two spines, with the sides bent up to form a gutter, and crowned on each side by spines intermingled with thick tufts of hairs; on the carapace this gutter is continued backwards for a short distance, and on each side an interrupted hairy groove runs back from the base of the rostrum along the sides of the flattened dorsal area to the cervical furrow, just before meeting which the grooves curve somewhat outwards. The anterior part of the flat area of the carapace is protected at the side by a raised ridge, which is continuous in front with the side ridges of the rostrum. Antennal tooth present, and pterygostomial angle produced but rounded; cervical furrow deep, and at the side running obliquely into a shallower depression, which continues it to the anterior edge of the carapace; outside the cervical groove a small crest of teeth on each side of the body; eye-stalks shorter than rostrum, cornea terminal; first joint of antennal stalk equal to second and third together, latter subequal; stalk of second antenna longer than that of first, scale narrow, strong, with five teeth beneath, spine on basal joint with four teeth outside and two longer teeth inside; third maxilliped longer by its last three joints than the antennal scale, meropodite with four spines on the inner edge, carpopodite with five, propodite and last joint nearly equal, latter elongate-oval; first pair of legs subequal, left stouter than right but otherwise similar, ischiopodite with a row of teeth below, meropodite with five or six rather large teeth above and a crest of small teeth below, immovable finger with one tooth, hand slightly broader than wrist, which bears a single tooth below; second pair of legs with a crest of teeth under the meropodite; second, third and fourth legs with a ventral process at the outer end of the ischiopodite; propodite of legs 3 and 4 with a thick fringe of hairs below; all the limbs hairy-tufted; abdomen longer than cephalothorax; telson with two transverse ridges, behind the second ridge two pairs of small tubercles, along the hinder and lateral borders a row of small, indistinct tubercles, hinder border straight and with

a fringe of hairs, uropods not longer than telson, with longitudinal ridges on the dorsal surface of, and toothed on the outer edge of both rami."

Length of male 57 mm., of female 55 mm.

1 ♂, 1 ♀ from Talili Bay, New Britain.

TRIBE. ANOMALA.

SUBTRIBE. GALATHEINEA.

FAMILY. GALATHEIDAE.

GENUS. *Galathea* Fabr., 1798.

51. *Galathea elegans* Adams and White, 1848.

Galathea elegans, Adams and White, Crust., "Samarang," p. 1, Pl. XII. Fig. 7 (1848).

1 ♀, with eggs, from New Britain.

52. *Galathea grandirostris* Stimps., 1858.

Galathea grandirostris, Stimpson, Proc. Ac. N. Sci. Philad., 1858, p. 90; Henderson, "Challenger" Anomura, p. 119, Pl. XII. Fig. 3 (1888).

2 ♂ and 2 ♀, from New Britain.

53. *Galathea australiensis*, Stimps., 1858.

Galathea australiensis, Stimpson, Proc. Ac. N. Sci. Philad., 1858, p. 89; Henderson, "Challenger" Anomura, p. 118, Pl. XII. Fig. 5 (1888).

1 ♂ from Lifu, Loyalty Islands.

54. *Galathea affinis* Ortm., 1892.

Galathea affinis, Ortmann, Zool. Jahrb. vi. Syst., p. 252, Pl. XI. Fig. 9 (1892).

2 ♂ from Lifu, Loyalty Islands.

55. *Galathea spinimanus* sp. n., Figs. 16a—16b.

Diagnosis:—"A *Galathea* with the rostrum broad, with one small and three large spines on each side and a terminal spine; carapace without gastric spines, with six spines at the side and one at the pterygostomial angle, scored with transverse pilose ridges, but without demarcation of the gastric region; third maxilliped with the meropodite as long as the ischiopodite, but narrower, and not bearing a spine on the outside, on the inside of the meropodite two moderately large and two small teeth, dactyle broad and ending in a tuft of hairs; first pair of legs longer than the thorax, covered with spines and hairs, fingers about equal to the palm, a small tooth on the inside of each finger; second, third and fourth legs covered with spines and hairs, dactyle not far short of the propodite in length, with no spines above, but a row of small spines below."

Length 9.5 mm. (♂).

1 ♂ 2 ♀ from Lifu, Loyalty Islands.

w. IV.

GENUS. *Munida* Leach, 1820.56. *Munida scabra* Hend., 1885.

Munida scabra, Henderson, Ann. Mag. N. H. (5) xvi. p. 409 (1885); "Challenger" Anomura, p. 134, Pl. XV., Fig. 1 (1888).

3 ♀ from Talili Bay, New Britain.

Var. *longipes* nov.

A male and two females, taken with the above typical specimens, differ from them in the greater length and slenderness of the legs of the first pair¹. It is proposed to call this variety *longipes*.

57. *Munida japonica* Stimps., 1858.

Munida japonica, Stimpson, Proc. Ac. N. Sci. Philad., 1858, p. 252; Ortmann, Zool. Jahrb. vi. Syst. 2, p. 254, Pl. xi. Fig. 11 (1892).

2 ♀ from Talili Bay, New Britain.

58. *Munida semoni* Ortm., 1894.

Munida semoni, Ortmann, Semon's "Forschungsreisen in Austral.," v. 1, p. 24, Pl. I. Fig. 4 (1894).

2 ♂ and 3 ♀ from Talili Bay, New Britain.

FAMILY. PORCELLANIDAE.

GENUS. *Petrolisthes* Stimps., 1858.59. *Petrolisthes hastatus* Stimpson, 1858.

Petrolisthes hastatus, Stimpson, Proc. Ac. N. Sci. Philad., 1858, p. 241; Ortmann, Zool. Jahrb. vi. Syst. 2, p. 260 (1892).

23 ♂ and 14 ♀ from Sariba, British New Guinea.

60. *Petrolisthes lamarcki* (Leach), 1820.

See P. Z. S., 1898, p. 464.

Type. 1 ♂ and 1 ♀ from Sariba, British New Guinea.

Var. *fimbriatus* Borradaile, 1898. 1 ♂ and 1 ♀ from Sandal Bay, Lifu, Loyalty Islands; 1 ♀ from Sariba, British New Guinea.

61. *Petrolisthes bispinosus* sp. n.

Diagnosis:—"A *Petrolisthes* with the front indistinctly trilobed, the middle lobe prominent, each lobe concave above; carapace covered with straight, continuous, pilose ridges and bearing on each side two epibranchial spines, but without spines on its hinder edge; chelipeds marked out into scales by pilose ridges, their meropodite with a blunt lobe on the inner edge, the wrist with the inner edge 5-lobed, the two proximal

¹ Taking in each case the average length of the carapace in the specimens before us as unity, the length of the first pair of legs is in *M. scabra* 3.5 and in var. *longipes* 5.2. The specimens of *longipes* are slightly smaller than those of the type.

lobes each ending in a minute spine, the rest finely serrate, the outer edge with a crest of sharp, curved teeth, the hand broad, with serrated edges, the fingers slightly hooked at the tip, equal, with serrated edges; the second to fourth pairs of legs with spines on the upper edge of the meropodite, dactyles with several small spines underneath; none of the legs hairy, save for a very few scattered hairs."

Length of carapace 4 mm.

This species belongs to the *galanthinus*-group of Ortmann [Zool. Jahrb. x. Syst., p. 276 (1897)].

1 ♂ from Sandal Bay, Lifu, Loyalty Islands.

GENUS. *Pachycheles* Stimps., 1858.

62. *Pachycheles sculptus* (H. M.-Edw.), 1837.

Porcellana sculpta, H. M.-Edwards, H. N. Crust. II. p. 253 (1837); Dana, U.S. Expl. Expd. Crust. I. p. 412, Pl. XXVI. Fig. 2 (1852); de Man, J. Linn. Soc. Zool. XXII. p. 218 (1888).

Porcellana pisum, H. M.-Edwards, H. N. Crust. II. p. 254 (1837); Heller, "Novara" Crust. p. 73 (1868).

Porcellana pulchella, Haswell, Proc. Linn. Soc. N.S.W. XI. p. 758 (1882); Cat. Austral. Crust. p. 148 (1882).

Porcellana (Pisosoma) sculpta, de Man, Arch. Naturg. LIII. p. 413 (1888).

Pachycheles pulchellus, Miers, "Alert" Report, p. 273, Pl. XXX. Fig. A (1884); Henderson, "Challenger" Anomura, p. 114 (1888); Ortmann, Semon's "Forschungsreisen in Austral." v. 1, p. 30 (1894).

Pisosoma sculptum, Ortmann, Zool. Jahrb. VI. Syst. p. 265 (1892); de Man, Zool. Jahrb. IX. Syst. p. 378 (1896).

Pisosoma pisum, de Man, Zool. Jahrb. IX. Syst. p. 380 (1896).

Pachycheles sculptus, Ortmann, Semon's "Forschungsreisen in Austral." v. 1, p. 29 (1894).

The occurrence in Dr Willey's collection of a form intermediate between the *Porcellana sculpta* and *P. pisum* of Milne-Edwards, leads to the conclusion that these latter are not specifically distinct, and must rank with the new form as varieties of one species. The following table sets forth the distinguishing characteristics of these varieties.

1. Chelipeds subequal, similar, tuberculated.

A. var. *sculptus* H. M.-Edw., 1837.

1'. Chelipeds unequal, dissimilar, one at least not tuberculated.

2. The left cheliped is the larger. Right cheliped tuberculated.

B. var. *tuberculatus* nov.

2'. The right cheliped is the larger. Neither cheliped tuberculated.

C. var. *pisum* H. M.-Edw., 1837.

The collection contains the following specimens:—

var. *sculptus*. 1 ♀ from Lifu, Loyalty Islands.

var. *tuberculatus*. 2 ♂ from Lifu, Loyalty Islands.

63. *Pachycheles lifuensis* sp. n.

Diagnosis:—"A *Pachycheles* with the front almost straight, slightly convex in the middle, depressed; carapace granular at the sides and with linear ridges on the branchiostegites; chelipeds unequal, the left the larger, the wrist and hand uniformly pubescent and granular, the wrist with three rather blunt lobes on the inner edge, but without teeth overhanging its articulation with the hand; second to fourth pairs of legs not so stout as in *barbatus*, the last three joints pubescent, the propodite armed with spines above, the dactyle with spines below."

Length of carapace 3.5 mm., breadth 4 mm.

This species is closely allied to *P. barbatus*, but is, I think, distinct.

1 ♂ and 1 ♀ from Lifu, Loyalty Islands.

SUBTRIBE. PAGURINEA.

FAMILY. PAGURIDAE.

GENUS. *Pagurus* Fabr., 1793.

64. *Pagurus deformis*, H. M.-Edw., 1836.

For references, etc., see P. Z. S., 1898, p. 460.

The male specimen of this species shows, as usual, the genital openings of the female.

From Lifu, Loyalty Islands. 1 ♀ in a *Dolium* shell, 1 ♀ in a *Turbo* shell bearing sea anemones, 1 ♂.

From the Conflict Group, British New Guinea. 1 ♀, berried, in a *Turbo* shell, bearing a sea anemone.

From New Britain; 2 ♀ in shells of *Dolium* and *Natica*.

65. *Pagurus gemmatus* H. M.-Edw., 1846.

Pagurus gemmatus, H. M.-Edwards, Ann. Sci. Nat. (3), x. p. 60 (1846).

The male of this species does not show the female openings found in the male of the allied *P. deformis*.

1 ♂ from New Britain, 1 ♂ from Sandal Bay, Lifu, Loyalty Islands; the latter in a *Dolium* shell bearing sea-anemones.

66. *Pagurus asper* de Haan, 1849.

Pagurus asper, de Haan, Faun. Japon. Crust., p. 208, Pl. XLIX. Fig. 4 (1849); Ortmann, Semon's "Forschungsreisen in Austral." v. 1, p. 31 (1894).

1 ♂ and 1 ♀ from Lifu, Loyalty Islands in *Turbo* shells.

67. *Pagurus setifer* H. M.-Edw., 1836.

For references see P. Z. S., 1898, p. 460.

2 ♂ from Lifu, Loyalty Islands. 2 ♀ from the Conflict Group, British New Guinea.

68. *Pagurus euopsis* Dana, 1852.

For references see P. Z. S., 1898, p. 461.

1 ♂ from the Conflict Group, British New Guinea.

69. *Pagurus punctulatus* Olivier, 1811.

For references see P. Z. S., 1898, p. 461.

2 ♂ and 1 ♀ from Lifu, Loyalty Islands.

70. *Pagurus strigatus* (Herbst), 1796.

Cancer strigatus, Herbst, Naturg. Krabben, II. 4, p. 25, Pl. LXI. Fig. 3 (1796).

Pagurus strigatus, Hilgendorf, Monatsbor. Ak. Wiss., Berlin, 1878, p. 820, Pl. II.

Fig. 8.

1 ♂ from Sandal Bay, Lifu, Loyalty Islands.

FAMILY. COENOBITIDAE.

GENUS. *Coenobita* Latr., 1826.

70. *Coenobita compressus* H. M.-Edw., 1837.

Coenobita compressa, H. M.-Edw., H. N. Crust. II. p. 241 (1837).

Coenobita compressus, Ortmann, Zool. Jahrb. VI. Syst., p. 318 (1892).

From Lifu, Loyalty Islands, 1 ♂ and 2 ♀, the latter in shells of *Nannia* and *Papuina*. From New Britain, 1 ♂ in a *Triton* shell. From Sandwich Island, New Hebrides, one berried ♀.

71. *Coenobita rugosus* H. M.-Edw., 1837.

For references see P. Z. S., 1898, p. 460.

1 ♂ and 12 ♀ from the Loyalty Islands.

72. *Coenobita perlatus* H. M.-Edw., 1837.

For references see P. Z. S., 1898, p. 459.

6 ♂ and 5 ♀ from Lifu, Loyalty Islands.

73. *Coenobita clypeatus* (Herbst), 1796.

For references see P. Z. S., 1898, p. 459.

2 ♂ and 4 ♀ from Lifu, Loyalty Islands.

74. *Coenobita spinosus* H. M.-Edw., 1837.

For references see P. Z. S., 1898, p. 459.

1 ♂ in a nutshell of *Calophyllum*, and 9 ♀ from Lifu, Loyalty Islands.

GENUS. *Birgus* Leach, 1815.75. *Birgus latro* (Linn.), 1766.

For references see P. Z. S., 1898, p. 458.

2 ♂ and 8 ♀ from Lifu, Loyalty Islands.

SUBTRIBE. HIPPINEA.

FAMILY. HIPPIDAE.

GENUS. *Remipes* Latr., 1806.76. *Remipes testudinarius* Latr., 1806.*Remipes testudinarius*, Latreille, Gen. Crust. Jus. I. p. 45 (1806); de Man, Zool. Jahrb. ix. Syst., p. 463 (1896).

1 ♂ and 2 ♀ from Sandal Bay, Lifu, Loyalty Islands.

77. *Remipes pacificus* Dana, 1852.

For references, etc., see P. Z. S., 1898, p. 467.

1 ♂, 14 ♀, from Sandal Bay, Lifu, Loyalty Islands. 7 small ♂ from the Isle of Pines, New Caledonia.

78. *Remipes celaeno* de Man, 1896.*Remipes celaeno*, de Man, Zool. Jahrb. ix. Syst., p. 483 (1896).

2 ♂ and 45 ♀ from Blanche Bay, New Britain. 1 ♀ from the Isle of Pines.

79. *Remipes ovalis* A. M.-Edw.*Remipes ovalis*, A. M.-Edw., Millard's "Notes sur Réunion," Ann. F., p. 12, Pl. XVII. Fig. 5 (1863); de Man, Zool. Jahrb. ix. Syst., p. 471 (1896).

3 ♀ from New Britain.

80. *Remipes admirabilis* Thallw., 1891.*Remipes admirabilis*, Thallwitz, Abh. Mus. Dresden, p. 36 (1891); de Man, Zool. Jahrb. ix. Syst., p. 466, Fig. 51 (1896).

5 ♂ from Blanche Bay, New Britain.

FAMILY. ALBUNEIDAE.

GENUS. *Albunea* Fabr., 1798.81. *Albunea microps* Miers, 1877.*Albunea microps*, Miers, J. Linn. Soc. Zool. XIV. p. 328, Pl. V. Figs. 12, 13 (1877).

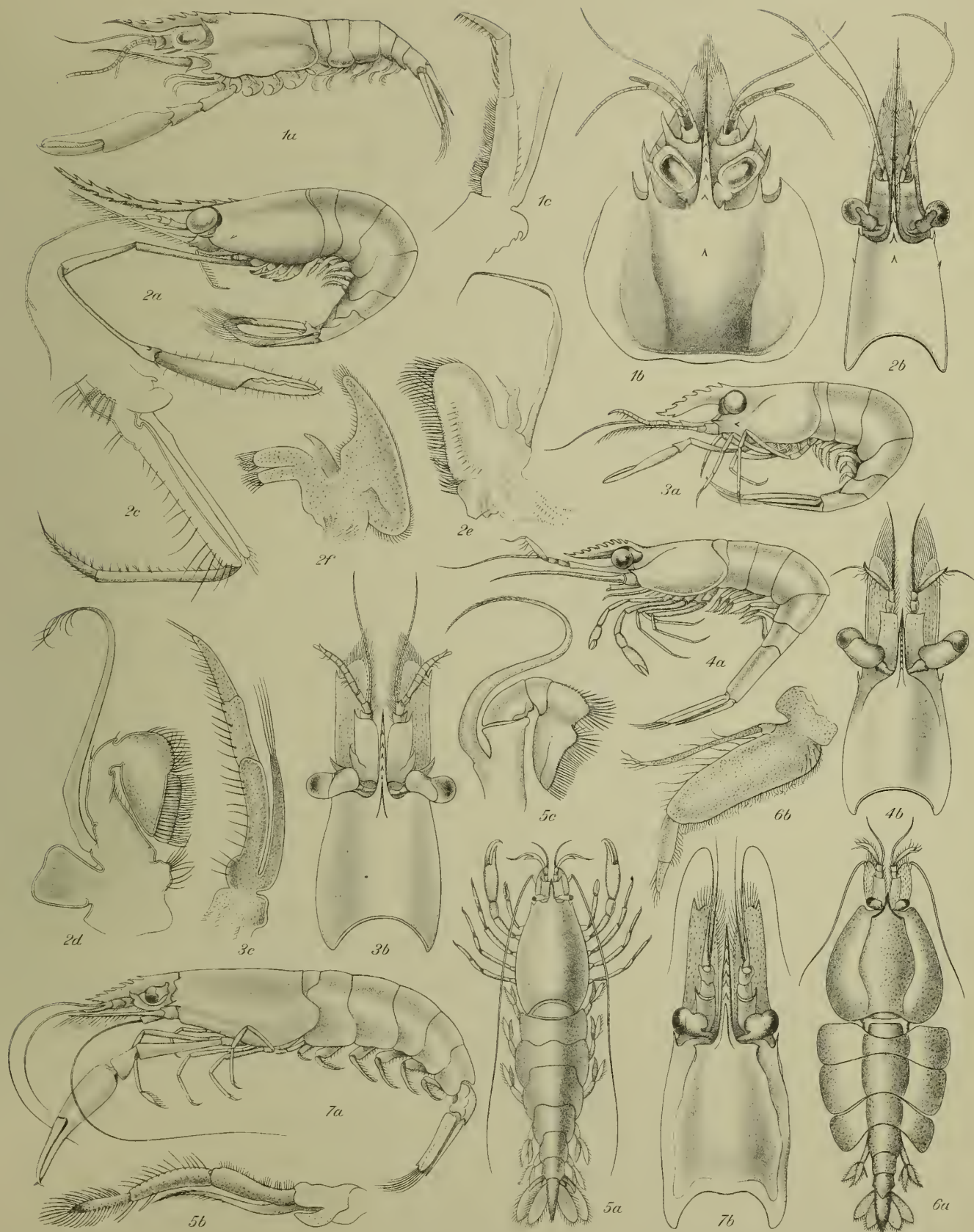
2 ♂ from Blanche Bay, New Britain.

EXPLANATION OF PLATES XXXVI.—XXXIX.

(Borradaile, Crustacea).

- FIG. 1. *Periclimenes lifuensis* Borradaile.
 „ 1 a. Side view $\times 6$.
 „ 1 b. Head and carapace from above. More highly magnified.
 „ 1 c. 3rd maxilliped. Magnified. The tip of the exopodite is broken off.
- FIG. 2. *Periclimenes tenuipes* Borradaile.
 „ 2 a. Side view $\times 4$.
 „ 2 b. Head and carapace from above. More highly magnified.
 „ 2 c. 3rd maxilliped. Magnified.
 „ 2 d. 2nd „ „
 „ 2 e. 1st „ „
 „ 2 f. 2nd maxilla. „
- FIG. 3. *Periclimenes parvus* Borradaile.
 „ 3 a. Side view $\times 9$.
 „ 3 b. Head and carapace from above. More highly magnified.
 „ 3 c. 3rd maxilliped. Magnified.
- FIG. 4. *Periclimenes parasiticus* sp. n.
 „ 4 a. Side view $\times 10$.
 „ 4 b. Head and carapace from above.
- FIG. 5. *Anchistus biunguiculatus* sp. n.
 „ 5 a. Dorsal view $\times 1\frac{1}{3}$.
 „ 5 b. 3rd maxilliped. Magnified.
 „ 5 c. 2nd maxilliped. „
- FIG. 6. *Pontonia ascidicola* sp. n. ♀.
 „ 6 a. Dorsal view $\times 5$.
 „ 6 b. 1st maxilliped. More highly magnified.
- FIG. 7. *Palaemonopsis willeyi* sp. n.
 „ 7 a. Side view $\times 3$.
 „ 7 b. Head and carapace from above.
 „ 7 c. Tail fin from above (Plate XXXVII.).
 „ 7 d. Mandible. Magnified. The projection on the fore edge in the figure is not part of a palp but is the base of the molar process.
 „ 7 e. First antenna.
- FIG. 8. *Pandalus serratifrons* sp. n.
 „ 8 a. Side view $\times 2$.
 „ 8 b. Head and carapace from above $\times 2$.
 „ 8 c. 3rd maxilliped $\times 3$.
 „ 8 d. End of first leg. Magnified.
- FIG. 9. *Pandalus tenuipes* sp. n.
 Side view, nat. size. The drawing does not adequately represent the thread-like appearance of the carpopodite and propodite of the legs, nor the fact that they are slightly swollen at the outer ends. These limbs are in the above respects unlike those of *P. serratifrons*.

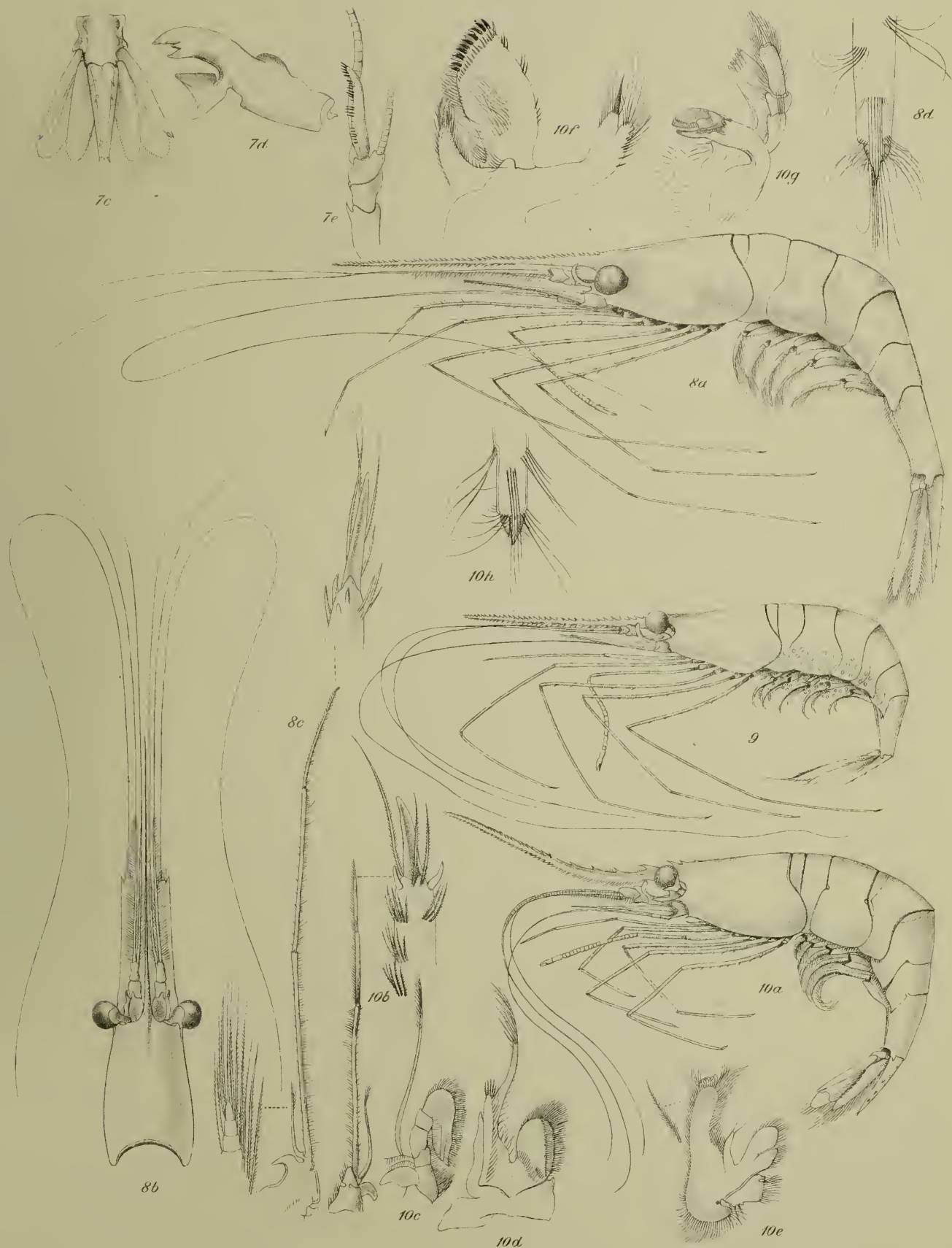
- FIG. 10. *Pandalus longirostris* sp. n.
 „ 10 *a.* Side view, nat. size.
 „ 10 *b.* 3rd maxilliped $\times 2$.
 „ 10 *c.* 2nd „
 „ 10 *d.* 1st „
 „ 10 *e.* 2nd maxilla.
 „ 10 *f.* 1st maxilla.
 „ 10 *g.* Left mandible.
 „ 10 *h.* End of 1st leg. Magnified.
- FIG. 11. *Parhippolyte uveae* sp. n.
 „ 11 *a.* Side view, nat. size.
 „ 11 *b.* Head and carapace from above $\times 1\frac{1}{3}$.
 „ 11 *c.* 3rd maxilliped $\times 3$.
 „ 11 *d.* 2nd „
 „ 11 *e.* 2nd maxilla.
 „ 11 *f.* 1st „
 „ 11 *g.* Mandible.
- FIG. 12. *Alpheinus tridens* sp. n.
 „ 12 *a.* Dorsal view $\times 3$.
 „ 12 *b.* 3rd maxilliped. Magnified.
 „ 12 *c.* 2nd „ „
 „ 12 *d.* 1st „ „
 „ 12 *e.* 2nd maxilla. Magnified.
 „ 12 *f.* 1st „ „
 „ 12 *g.* Mandible. „
- FIG. 13. *Alpheus aglaopheniae* sp. n.
 „ 13 *a.* Side view $\times 6$.
 „ 13 *b.* Head and carapace from above $\times 10$.
 „ 13 *c.* 3rd maxilliped.
 „ 13 *d.* Larger leg of first pair.
 „ 13 *e.* Leg of second pair.
 „ 13 *f.* „ third „
- FIG. 14. *Callianassa novae-britanniae* sp. n.
 „ 14 *a.* Anterior part of body from above $\times 3$.
 „ 14 *b.* Tail fin from above $\times 2$.
 „ 14 *c.* 3rd maxilliped $\times 3$.
 „ 14 *d.* Larger leg of first pair $\times 2$.
- FIG. 15. *Eiconaxius taliliensis* sp. n.
 „ 15 *a.* Side view $\times 2$.
 „ 15 *b.* Head and thorax from above $\times 4$.
 „ 15 *c.* Tail fin from above $\times 2$.
- FIG. 16. *Galathea spinimanus* sp. n. Dorsal view of body $\times 6$.
- FIG. 17. *Alpheus diadema* Dana.
 „ 17 *a.* Larger leg of first pair $\times 7$.
 „ 17 *b.* Smaller „ „ $\times 9$.



F O P-C. del

BORRADAILE, CRUSTACEA-MACRURA.

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BORRADAILE, CRUSTACEA - MACRURA

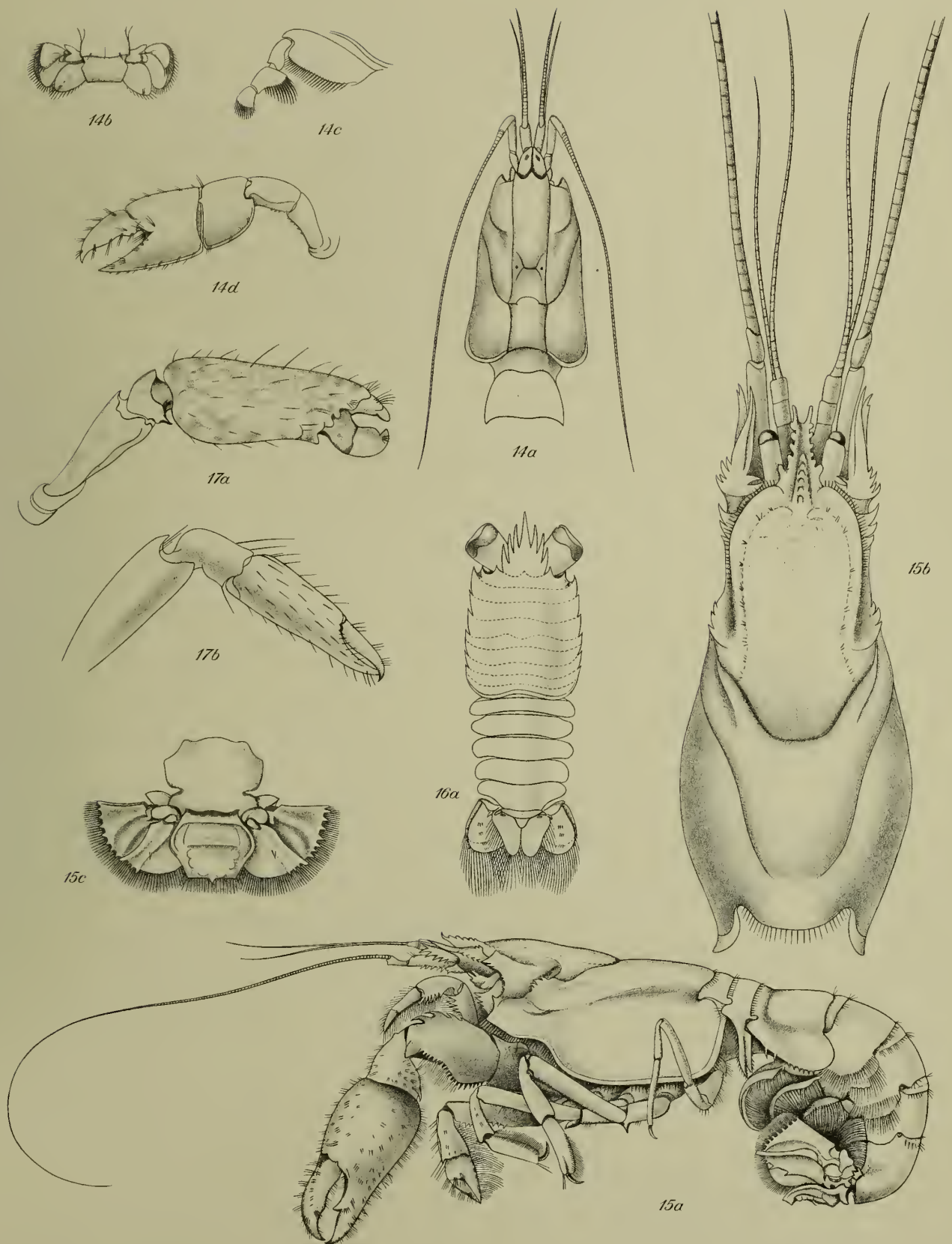
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F.O.P.C. del.

BORRADAILE, CRUSTACEA MACRURA.

E. Wilson, Cambridge



REPORT ON THE SLUGS.

BY WALTER E. COLLINGE, F.Z.S.,
Mason University College, Birmingham.

With Plates XL. and XLI.

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I. INTRODUCTION.

THE collection of slugs made by Dr Willey, although not a large one, is of exceptional interest in that it includes a series from a region which as yet has only been very imperfectly worked.

The specimens which are here described belong to two families,—*Veronicellidae* and *Janellidae*—and include six species of which two are new, and two varieties, both of which are new.

So far as I am aware there are no previous records for any species of *Veronicella* from either the Loyalty Islands or the New Hebrides, and Professor Simroth informs me that he also knows of no such records. It is interesting to find amongst the specimens collected in the New Hebrides, the two Australian species *V. leydigi*, Simr., and *V. hedleyi*, Simr.

In dealing with a family of molluscs like the *Veronicellidae*, one is very forcibly impressed with the little value that can be attached to the external form and colour. In spite of all the arguments in support of describing and identifying such molluscs from these features, here they are quite secondary, and to attach to them any special importance would only lead to endless confusion; a reference to the works of Semper and Simroth will illustrate the great similarity in colour and external markings that exists, in species which are widely separated both geographically and anatomically. Thanks to the work of the above-mentioned malacologists, we have anatomical details for a large number of species in this family, and in separating those here enumerated I have been guided almost entirely by their structure. It is much to be regretted that we have as yet no account of the developmental history of some species of *Veronicella*, for such a study would, I strongly believe, throw much light upon their systematic position and their affinities to other families.

At present it is difficult to say what characters may be regarded as affording the best criteria for specific distinction, the chief points which I have here directed attention to, where the material has permitted, are those enumerated by Simroth¹, viz.:

- a. The relations of the intestine to the liver.
- b. The differences in the distance between the terminal portion of the intestine and the female genital orifice.
- c. The form and structure of the pedal gland.
- d. The form of the salivary glands.
- e. The terminal ducts of the male generative organs, particularly the receptaculum seminis and vas deferens.
- f. The thickness and structure of the notum.

Of the second family, the *Janellidae*, there are two species, one of which has formed the subject of part of an elaborate memoir by Plate², the other is an immature example of *Aneitea*, probably *A. hirudo*, P. Fischer³.

I desire to express my best thanks to Professor H. Simroth for kind assistance, and to Professor L. H. Plate, who very kindly sent me the type specimen and dissected parts of *Janella schauinslandi* Plate, from the Bremen Museum, for comparison.

¹ Zool. Jahrb. (Abth. f. Syst.), 1890, Bd. v, p. 902.

² Zool. Jahrb. (Abth. f. Anat.), 1898, Bd. II, pp. 193—280, Taf. 12—17.

³ Journ. de Conchyl., 1868, T. xvi, pp. 145—46, 225—34, pl. xi.

II. SPECIES FROM THE LOYALTY ISLANDS.

1. *Veronicella willeyi*, sp. nov. (Pls. XL.—XLI. Figs. 1—14).

Habitat. Lifu, Loyalty Islands. Numerous.

The colour of this species is exceedingly variable, the majority of specimens were a dirty yellowish-brown dorsally, irregularly blotched with black, which markings become more closely set laterally, forming a broken line; there is a well-marked median dorsal yellowish-brown line, while the extreme anterior and posterior portions of the body are a dark bluish-black. The two specimens figured (Pl. XL. Figs. 1 and 3) show the dark and light coloured forms. The hypnotum and foot-sole are almost white.

Length (in alcohol) 48 mm.; foot-sole 5 mm. broad; hypnotum 6 mm. broad; female generative orifice on the right side 1.5 mm. from the foot-sole, 27.5 mm. from the right lower tentacle, and 20.5 mm. from the posterior end of the body.

I have pleasure in associating with this interesting species the name of Dr Willey.

ANATOMY.

I. *Digestive System.*

The mouth is somewhat oval shaped. The buccal cavity calls for no special mention. The salivary glands are profuse and lie at the anterior part of the pharynx, and upon the dorsal side of the buccal cavity. The right gland is slightly smaller than the left one, a feature, I believe, common to all species of *Veronicella*, in consequence, as pointed out by Simroth¹, of the anterior portion of the male organs restoring symmetry. To the naked eye the separation between the two glands is scarcely distinguishable; under the microscope, however, each is seen to consist of a series of fine dendritic tubes, each of which terminates in one or more small, flat, sac-like bodies (Pl. XL. Figs. 6 and 7). The whole mass is very compact and forms a conspicuous yellowish-white body above the hinder portion of the buccal cavity and the anterior portion of the pharynx (Pl. XL. Figs. 5 and 6).

The oesophagus is short, giving place to a wide, thin-walled crop (the fore-stomach of Simroth and others) which becomes constricted just in front of the stomach (Pl. XL. Fig. 4). The disposition of the intestinal loops is very much the same as in *V. hennigi*, Simr. (*l.c.* (1) Taf. XLIX. Fig. 12), though in form and structure the digestive tract is more closely related to *V. hedleyi*, Simr.

We may conveniently divide the intestinal canal into four loops, the first extending from the buccal cavity to the stomach, the second from the stomach to the anterior lobe of the liver, the third lying superficially in the liver, from the anterior lobe, and making a somewhat [-shaped bend, which, on leaving the liver, becomes loop number four, this terminating at the cloacal chamber. The third loop lies dorsal to the crop

¹ T. c., p. 866.

imbedded in the substance of the liver, and enters as loop number four into the body wall just behind the opening of the female generative orifice. The anterior portion of loop four passes backwards above the kidney, posteriorly it is covered by the body-wall only, and terminates on the ventral side of the cloacal chamber (Pl. XL. Figs. 9 and 11).

The whole of the intestinal tract, it will thus be seen, is practically imbedded in the liver, so that *V. willeyi* in this particular agrees with that group of *Veronicella* which would also contain *V. hennigi*, Simr., and *V. hedleyi*, Simr.

I was not able to detect any ring-like swelling between the oesophagus and crop, but between the terminal portion of the crop and the commencement of the stomach there is a thick muscular ring-like constriction, immediately behind which the hepatic ducts open.

II. *The Pedal Gland.*

Although approaching somewhat the condition which obtains in *V. leydigi*, Simr., there are a few well-marked features in the gland of *V. willeyi* in which it differs from the former.

The gland commences as a slit-like opening, e.g. \subset , immediately above the foot-sole, the anterior edges of the latter partly hiding the opening of the gland. Lip-like protuberances form the boundaries of the commencement of the cavity. The gland lies free in the body-cavity upon the dorsal side of the muscles of the foot-sole. The anterior portion is slightly wider than the rest of the gland, agreeing in this particular in all the specimens dissected. In general shape and size considerable differences were noted (Pl. XL. Fig. 8 *a-c*); in all the specimens, however, some portion, either to the right or left, was turned forwards (Pl. XL. Fig. 8 *a, b, c*).

In transverse section the lumen of the gland is almost circular, the glandular wall being about twice the width of the lumen. The epithelial lining of the gland is continuous around the cavity.

III. *The Kidney, Lung and Pallial Organs.*

In *V. willeyi* I have been able to trace the ureter, and have figured in some detail the relations of kidney and ureter with the lung and the hinder part of the intestine (Pl. XL. Figs. 9 to 11).

The general structure of these organs calls for no special mention excepting that here the trabecular tissue is very dense and much folded. In general outline the kidney is not unlike that in *V. leydigi*, Simr., only differs in extending for some short distance below the hinder part of the intestine; posteriorly it narrows and opens into the rectum by a short but wide ureter which is plainly visible under a low-power dissecting microscope. Towards the outer wall of the pericardium and on the dorsal side is a minute but very distinct slit-like opening, which seems to be connected with the anterior and inner portion of the kidney. Possibly this is the reno-pericardial opening, but as I was unable to verify this by the transverse sections, it must be regarded only as a supposition that this is the true reno-pericardial opening. On the

outer side of the kidney is the lung, which also proceeds very far backwards, extending to a point just beyond the terminal portion of the kidney (Pl. XL. Fig. 9). The terminal portion of the respiratory duct opens separately from that of the combined rectum and ureter, and slightly above it, so that there is a distinct cloacal chamber into which these two ducts open (Pl. XL. Fig. 11). The external opening of this chamber lies on the right side of the hypnotum (Pl. XL. Fig. 2).

IV. *The Generative System.*

Although conforming in general to the type of reproductive organs common to *Veronicella*, there are certain well-marked features which have specific value.

The hermaphrodite gland is pyriform in shape, and has a closely convoluted duct which is enclosed in a fine membranous sheath (Pl. XL. Fig. 12, *h. d.*) at its base, and lying upon, and in life completely hidden by, the albumen gland, is a small diverticulum, the *vesicula seminalis* (Pl. XL. Fig. 12, *v. s.*). The albumen gland is a loose glandular organ not unlike that in *V. leydigi*, Simr. The oviduct is a long wide tube, twisted many times upon itself. The middle portion is the widest, while its commencement is the narrowest; it also becomes narrow again before opening externally. The *vas deferens* is a narrow tube, and bears at its lower end a large spermatocyst, which has a duct of some considerable length (Pl. XL. Fig. 12, *sp.*). At the opposite side of the vas deferens, at the point where the duct of the spermatocyst enters, a duct is given off to the receptaculum seminis. The form and position of the spermatocyst, together with its duct, is very characteristic of this species and separates it from any allies. The *receptaculum seminis* is a large ovoid body, with a long twisted duct (Pl. XL. Fig. 12, *rs., rd.*).

In the male organs I follow Simroth in terming the penis-gland of Semper, the dart-gland or dart-sac.

The penis is enclosed in a thick muscular sac, and in general outline and structure (Pl. XL. Fig. 13, *p.*) agrees very closely with that figured by Simroth for *V. leydigi*¹, being long and conical in shape and having an oblique slit at the top; there is, however, in *V. willeyi*, quite a large vestibule into which the penis opens, slightly above the opening of the dart-sac. Attached to the penis, just below the point of origin of the vas deferens, is a strong retractor muscle, and a smaller one just below the vestibule (Pl. XL. Fig. 13, *rm., rm.*). The dart-sac is rather longer and wider than the penis (Pl. XL. Fig. 13, *ds.*). At the base of the sac there is a small conical papilla, the dart (Pl. XL. Fig. 13, *d.*), and connected with this, but outside the actual dart-sac, are a series of long thread-like accessory glands (Pl. XL. Fig. 13, *ac. gl.*); these all open at the base of the papilla or dart, the opening at the apex of the dart forming a common orifice. The number of these accessory glands was not constant, the average is 15, but in one case there were only 12, while in another there were as many as 20.

Whether or not this dart-gland is homologous with the dart-sac in other Pulmonates, e.g. *Parmarion*, *Damayantia*, or with the dart-sacs in certain species of *Helix* and *Zonites*, which contains an imperforate calcareous dart, I at present hesitate

¹ Cp. T. c. Taf. L, Fig. 4.

to say. Simroth certainly thinks they are, for he writes (*l.c.*, p. 879), "Die Summe dieser Daten macht es wohl mehr als wahrscheinlich, dass auch bei den Vaginuliden das Reizorgan als Liebespfeil zu deuten sei."

V. *The Integument.*

The body-wall of the dorsum or notum is somewhat thin; in transverse section it is seen (Pl. XLI. Fig. 14) to consist of an outer epidermal layer, immediately beneath which is a dense layer of blackish pigment. This layer also borders the sides of the mucous glands; of these latter I have obtained very good sections by freezing, staining with an aqueous solution of magenta, and mounting in a glycerine fluid. The lumen of the gland is narrow, becoming in most cases slightly larger at the base; around this canal are a series of bladder-like cavities, which probably serve as reservoirs for the mucous.

Excepting that the notum in *V. willeyi* is thinner than that described by Simroth in *V. leydigi*, my observations agree practically in all particulars with his. In the mucosa, the concretions which Simroth thinks may be uric acid, were very plentiful and in a few cases very large.

2. *Aneitea hirudo*?, P. Fisch. (Pl. XLI. Figs. 15—17.)

Hab. Lifu. One specimen.

After a careful comparison of this small species with all the described forms, I am placing it with a query under *A. hirudo*, P. Fisch. From the imperfect development of the generative organs I conclude it is a young example. It agrees with Fischer's figure¹ of *A. hirudo* in the form of the penis (Pl. XLI. Fig. 16, *p.*).

The whole of the body is a dirty greyish-brown colour, with a few blotchy black markings on the lateral portions of the body. There is an ill-defined median-dorsal groove with oblique lateral grooves directed posteriorly and ventrally. The margin of the dorsum (perinotum) is wavy. The foot-sole is marked by a series of closely set transverse markings. In transverse section the body appears almost triangular (Pl. XLI. Fig. 17).

The dimensions are as follows:—

Length over back, from head to tip of the tail	22·5 mm.
Length of foot-sole	19·5 mm.
Width over back	10 mm.
Breadth of foot-sole	6·5 mm.
Distance of anus from right tentacle	6·5 mm.
" " " respiratory orifice.....	1 mm.
Length of mantle	7 mm.

¹ *Journ. de Conchyl.*, 1868, T. XVI, pl. XI.

III. SPECIES FROM THE NEW HEBRIDES.

1. *V. brunnea*, sp. nov. (Pl. XLI. Figs. 18—23).

Hab. Esafate, one specimen.

This is a very interesting form, and I regret, owing to lack of material, not to be able to give a fuller account of its anatomy.

Externally it is a deep brown with small black blotches sparingly distributed over the dorsum (notum), the perinotum is very prominent and much darker in colour. I know of no other species of *Veronicella* in which the perinotum is so prominent and so well defined, standing out quite distinct from either the notum or hypnotum. My knowledge of the genus is not a wide one, so possibly this is a feature met with in other species, still I find no mention of it in any of the species described by Semper or Simroth. The hypnotum is rather lighter in colour and free of any markings; foot-sole yellowish-brown, and marked by a series of transverse divisions.

Length (in alcohol) 18.5 mm.; foot-sole 3 mm. broad; hypnotum 4.5 mm. broad; female generative orifice on the right side 1.5 mm. from the foot-sole, 10.5 mm. from the right lower tentacle and 7 mm. from the posterior end of the body.

The only parts I have examined anatomically are the digestive system and pedal gland. The former, excepting in the position of the loops of the intestine and stomach, calls for no special mention. All the loops are imbedded in the lobes of the liver, those visible on the dorsal surface being the anterior portion of loop 2, and nearly the whole of loop 3 (Pl. XLI. Fig. 19). At the posterior portion of the stomach, and on the ventral side, is a small bean-shaped glandular body, connected by a series of fine ducts (Pl. XLI. Figs. 20—22). I have not previously met with any similar body in any other species of *Veronicella*. Possibly it functions as a digestive gland.

The pedal gland commences as a wide thin non-glandular(?) sac, lying free in the body cavity, giving place in the posterior half to a narrower glandular part. At its extreme end it makes a bend to the right side (Pl. XLI. Fig. 23).

2. *V. leydigi*, Simr.

Hab. Esafate, two specimens.

I have nothing to add to the admirable account given by Simroth¹ of this species. One specimen is immature.

3. *V. hedleyi*, Simr.

Hab. Esafate, one specimen.

This specimen agrees in nearly all particulars with the figure made by Hedley and given by Simroth².

¹ T. c., pp. 865—899.

² T. c., Taf. XLIX, fig. 7.

IV. SPECIES FROM NEW BRITAIN.

1. *Aneitella berghi*, (Pl. XLI. Figs. 24—27).

Hab. Karavia, Gazelle Peninsula. Numerous.

This species was first described by Plate¹ in 1898, who gives numerous figures of the internal structure, but the external features are scarcely done justice to. Seeing how very imperfectly figured most of the *Janellidae* are, a fact I have previously drawn attention to², I have given two figures of the external form (Pl. XLI. Figs. 24—25).

The specimens investigated by Plate were from Stephen's Island, New Zealand.

All the specimens I have dissected show a little variation in the form of the generative organs from those figured by Plate (*l.c.*, Taf. 16, Fig. 55). In one specimen the penis exhibited a well-marked fold, as figured (Pl. XLI. Fig. 27).

The dimensions of the largest specimen are:—

Length over back, from head to extreme posterior	48·5 mm.
Length of foot-sole	45 mm.
Width over back	24 mm.
Breadth of foot-sole	7 mm.
Distance of anus from right tentacle	9·5 mm.
" " " respiratory orifice	2 mm.
Length of mantle	9 mm.

With the typical examples were two well-marked colour variations, which are described below.

Var. nov. *albida*.

Hab. Karavia, New Britain, two specimens.

Whole of body a pure white. Length (in alcohol) 46 mm.

Var. nov. *fuscopallescens*.

Hab. Karavia, New Britain.

Whole of animal a pale brownish-yellow, with little, if any, black mottling. Length (in alcohol) 38 mm.

¹ T. c., p. 197.

² *Proc. Zool. Soc.*, 1894, p. 530.

EXPLANATION OF PLATES XL. AND XLI.

(Collinge, *Slugs*.)*Veronicella willeyi*, sp. nov.

- FIG. 1. View from dorsal side. Nat. size.
 FIG. 2. View from ventral side. Nat. size. ♀ female generative orifice. *cl.* opening of cloacal chamber.
 FIG. 3. Light coloured form, view from dorsal side. Nat. size.
 FIG. 4. Intestine and liver. $\times 2.5$. *æ.* œsophagus. *cr.* crop. *st.* stomach. *int¹*.—*int⁴*. the four loops of the intestine. *l.* liver. The dotted portion indicates the terminal portion of the intestine imbedded in the body wall.
 FIG. 5. Salivary glands as seen from the dorsal surface.
 FIG. 6. Portion of the same, slightly magnified, showing the salivary ducts, *s. d.* and their position in relation to the pharynx, *ph.* and the buccal cavity, *b. c.*
 FIG. 7. Terminal portion of the same, showing sac-like bodies.
 FIG. 8. Pedal gland showing variations met with. *a*, *b*, and *c.* $\times 2$.
 FIG. 9. Mantle organs seen from the ventral side. *atr.* atrium. *p.* pericardium. *v.* ventricle. *k.* kidney. *l.* lung. *cl. ch.* cloacal chamber. *res. d.* respiratory duct. *ur.* ureter.
 FIG. 10. Terminal portions of the intestine, kidney and lung. Lettering as in Fig. 9.
 FIG. 11. Terminal portions of the intestine and respiratory duct, showing their openings into the cloacal chamber *cl. ch.* *a.* anus. *r. o.* respiratory orifice. *int⁴*. posterior portion of the intestine.
 FIG. 12. Generative organs. *alb. gl.* albumen gland. *h. d.* hermaphrodite duct. *h. gl.* hermaphrodite gland. *ov.* oviduct. *r. d.* receptacular duct. *r. s.* receptaculum seminis. *sp.* spermatocyst. *v. d.* vas deferens. *v. s.* vesicula seminalis.
 FIG. 13. Terminal ducts of the male generative organs. *ac. gl.* accessory glands. *d.* dart. *d. s.* dart-sac. *p.* penis. *r. m.* and *r. m'.* retractor muscles of the penis. *v.* vestibule. *v. d.* vas deferens.
 FIG. 14. Transverse section through the dorsum. *ep.* epidermis. *gl.* glands. *mu.* mucous layer containing uric acid (?) concretions *u. c.* *m. f.* muscle fibres.

Aneitea hirudo, P. Fisch.

- FIG. 15. Lateral view of the animal from the right side. $\times 2$.
 FIG. 16. Vagina *vg.* and penis *p.* of the same.
 FIG. 17. Diagrammatic transverse section through the body. $\times 1$.

Veronicella brunnea, sp. nov.

- FIG. 18. View from the dorsal side. $\times 2$.
 FIG. 19. Intestine and liver. $\times 4$. Lettering as above.

FIGS. 20, 21. Dorsal and ventral view of the stomach, the latter showing the position of the small bean-shaped gland.

FIG. 22. Bean-shaped gland detached.

FIG. 23. Pedal gland.

Aneitella berghi, Plate.

FIG. 24. View from the dorsal side. $\times 2$.

FIG. 25. The same, from the ventral side. $\times 2$.

FIG. 26. Generative organs.

alb. gl. albumen gland.

f. ov. free oviduct.

gl. gland (?)

h. d. hermaphrodite duct.

h. gl. hermaphrodite gland.

p. penis.

pr. prostate.

r. m. retractor muscle.

r. s. receptaculum seminis.

v. vestibule.

v. d. vas deferens.

vg. vagina.

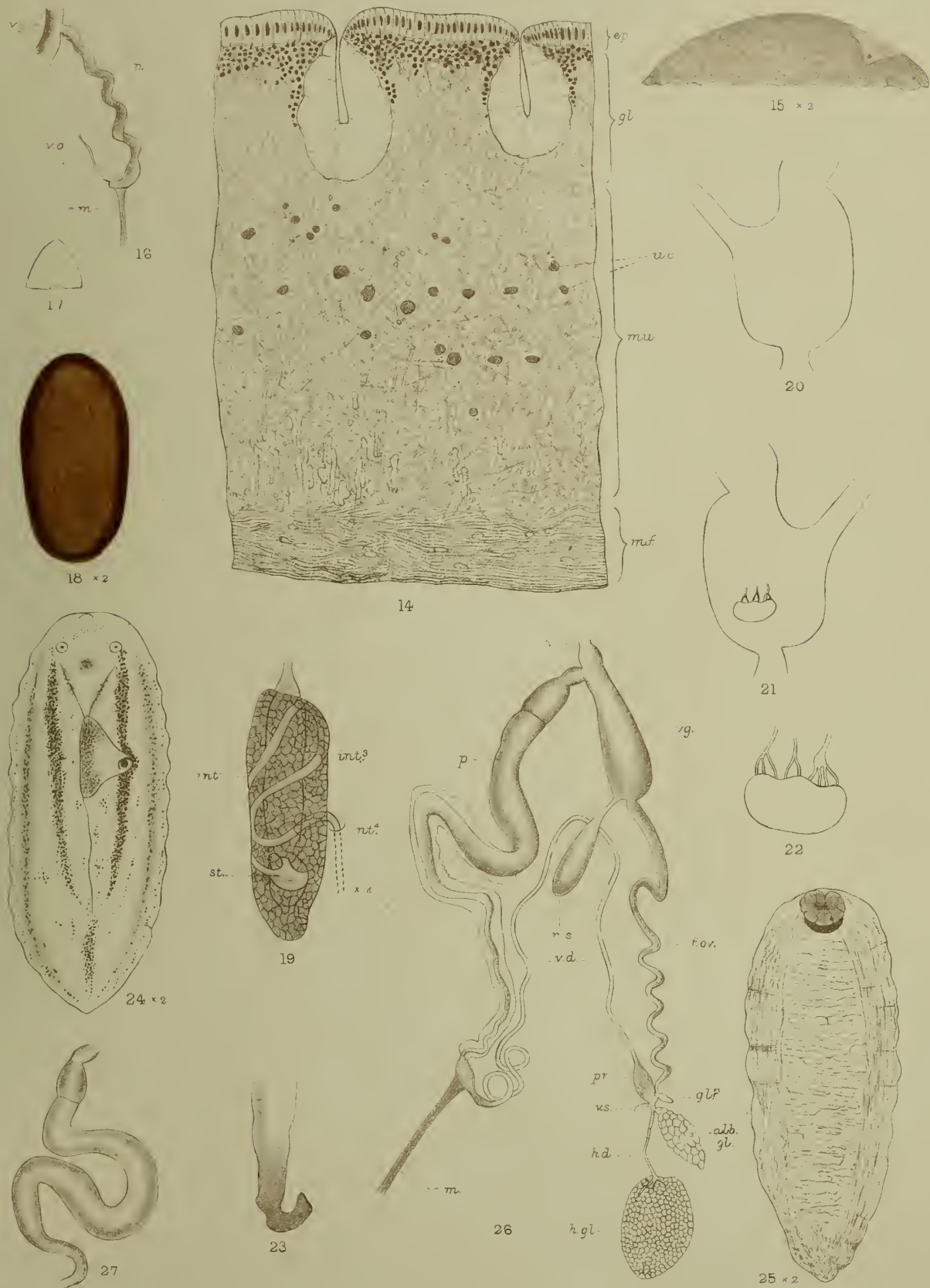
v. s. vesicula seminalis.

FIG. 27. Variation in the form of the penis.



W.E.C. del. ad nat.

West, Newman lith.



W.E.C. del. at nat.
T.J. Partridge del. Fig. 14.

West, Newman lith.

REPORT ON THE POLYZOA COLLECTED BY DR WILLEY FROM THE LOYALTY ISLES, NEW GUINEA AND NEW BRITAIN.

By E. G. PHILIPPS,
Newnham College, Cambridge.

With Plates XLII. and XLIII.

THE Polyzoa collected by Dr Willey were obtained mainly from Lifu, in the Loyalty Isles.

The collection contains 63 species of which 9 are new. They are divided among the three sub-orders as follows:

Cheilostomata 46 species.
Cyclostomata 16 species.
Ctenostomata 1 species.

The specimens were compared with those in the British Museum and in the Cambridge University Museum of Zoology, to which Dr Willey has presented his collection. I wish to express my thanks to Mr Kirkpatrick for facilities afforded me at the British Museum and especially to Dr Harmer for the interest he has taken in my work and the very kind help he has given me.

The nomenclature adopted in this paper is that used in Miss Jelly's "Synonymic Catalogue of Marine Bryozoa," in which full references are given to the literature on the group.

Cheilostomata.

1. *Catenaria otophora*, Kirkp. D'Entrecasteaux Group, British New Guinea.
2. *Caberea lata*, Busk. Sandal Bay, Lifu, 17 fathoms.
3. *Canda retiformis*, Pourt. Sandal Bay, Lifu, 30 to 40 fathoms.
4. *Scrupocellaria scrupea*, Busk. Lifu.
5. *Scrupocellaria macandrei*, Busk. Sandal Bay, Lifu.
6. *Scrupocellaria annectens* MacGill. Karakoai. New Britain, 2 to 3 fathoms.

7. *Didymia triserialis*, n. sp. Beach of the Ile du Phare, Noumea, New Caledonia.
8. *Bugula dentata*, Lamx. Lifu.
9. *Bugula avicularia*, Linn. Sandal Bay, Lifu.
10. *Bugula neritina*, Linn. Sandal Bay, Lifu.
11. *Tubucellaria cereoides*, Ell. and Sol. Lifu.
12. *Cribrilina radiata* var. β , Hincks. Sandal Bay, Lifu, 17 fathoms.
13. *Membranipora radificera*, Hincks. var. *intermedia*, Kirkp. Sandal Bay, Lifu, 30 to 40 fathoms.
14. *Membranipora lacroixii*, Aud. Blanche Bay, New Britain.
15. *Membranipora irregularis*, d'Orb. Blanche River, New Britain.
16. *Membranipora coronata*, Hincks. Lifu.
17. *Membranipora punctigera*, Hincks. Sandal Bay, Lifu.
18. *Micropora* sp. Lifu.
19. *Monoporella polymorpha*, n. sp. Lifu.
20. *Monoporella spinifera*, n. sp. Lifu.
21. *Schizoporella biaperta*, Mich. Lifu.
22. *Schizoporella torquata*, Q. and G. Beach of the Ile du Phare, Noumea, New Caledonia.
23. *Schizoporella triangula*, Hincks, Blanche River, New Britain, 40 fathoms.
24. *Schizoporella striatula*, Smitt, Lifu.
25. *Schizoporella sanguinea*, Norman, Lifu.
26. *Schizoporella nivea*, Busk. Beach of Ile du Phare, Noumea, New Caledonia.
27. *Schizoporella depressa*, n. sp. Lifu.
28. *Hippothoa divaricata*, Lamx. Lifu.
29. *Thalamoporella rozieri*, form *indica*, Aud. Deboyne Lagoon, Louisiades.
30. *Microporella ciliata* var. *personata*, Busk. Lifu.
31. *Adeonellopsis violacea* var. *plagiopora*, Hincks. Sandal Bay, Lifu.
32. *Lepralia feegeensis*, Busk. Lifu.
33. *Lepralia poissonii*, Aud. Lifu, 35 fathoms.
34. *Lepralia tuberculata*, n. sp. Lifu, 35 fathoms.
35. *Lepralia calyciformis*, n. sp. Lifu.
36. *Smittia marmorea*, Hincks. Sandal Bay, Lifu, 35 fathoms.
37. *Mucronella articulata*, n. sp. Sandal Bay, Lifu, 30 to 40 fathoms.
38. *Rhynchozoon bispinosum*, Johnst. Lifu.
39. *Rhynchozoon crenulatum*, Waters. Lifu.
40. *Escharoides spinigera*, n. sp. Lifu, 35 fathoms.
41. *Cellepora speciosa*, MacGill. Sandal Bay, Lifu.
42. *Cellepora mamillata*, Busk. Sandal Bay, Lifu.
43. *Cellepora simplex*, MacGill. Sandal Bay, Lifu.
44. *Cellepora longirostris*, MacGill. Lifu.
45. *Retepora phoenicea*, Busk. Sandal Bay, Lifu.
46. *Retepora denticulata*, Busk, Lifu.

Cyclostomata.

47. *Crisia aculeata*, Hassall, Lifu.
48. *Crisia denticulata*, Lamk. Lifu.
49. *Tubulipora*, sp. Lifu.
50. *Idmonea interjuncta*, MacGill. Lifu.
51. *Idmonea radians*, Lamk. Lifu.
52. *Idmonea australis*, MacGill. Lifu.
53. *Entalopora delicatula*, Busk. Sandal Bay, Lifu, 17 fathoms.
54. *Hornera spinigera*, Kirkp. Lifu.
55. *Lichenopora verrucaria*, Fabric. Lifu.
56. *Lichenopora holdsworthii*, Busk. Lifu.
57. *Lichenopora hispida*, Fleming. Lifu, 17 fathoms.
58. *Lichenopora ciliata*, Busk. Lifu, 17 fathoms.
59. *Lichenopora californica*, D'Orb. Sandal Bay, Lifu.
60. *Lichenopora truncata*, n. sp. Lifu.
61. *Radiopora cristata*, Busk. Lifu.
62. *Fasciculipora carinata*, Ortmann. Ile du Phare, New Caledonia.

Otenostomata.

63. *Zoobotryon pellucidum*, Ehrenberg. Isle of Pines.

1. *Catenaria otophora*, Kirkpatrick.

Kirkpatrick, Ann. Mag. Nat. Hist. (6) v. 1890, p. 17.

A few colonies of this delicate species occur, growing on the Alcyonarian *Clavularia viridis*.

2. *Caberea lata*, Busk. Busk, Brit. Mus. Cat. i. 39. Fairly common in Lifu.

3. *Canda retiformis*, Pourtalès. (Pl. XLII., fig. 1.)

Canda retiformis, Pourt. Bull. Mus. Zool., Camb., U. S., 1867, Vol. i., p. 110.

Caberea retiformis, Smitt. "Floridan Bryozoa" in Kongl. Svenska Vetenskaps-Akad. Handl. 1872—1873, p. 16.

Compare *Canda arachnoides*, Brit. Mus. Cat. i. 26 and Busk, Challenger Report, xxx. 25.

The specimens, which are common in Lifu, seem to be intermediate between *Canda retiformis*, Pourtalès and *Canda arachnoides*, Lamouroux. The fornix is well developed, its lamina being as long as the aperture, rounded at the base, produced and pointed above. It differs in this respect from the specimen of *Canda retiformis* (from Victoria Bank, Brazil) in the British Museum, in which the lamina is small and equally developed on both sides of the stalk. Smitt however (Flor. Bryozoa, i. Pl. V., fig. 44) figures the fornix in this species as varying considerably in form.

On each side of the upper margin of the aperture there is a spine, the two being equally developed.

The specimen from Brazil, moreover, has no avicularia and this appears to be characteristic of Pourtales' form. The Lifu specimen has prominent avicularia along the median line of the branch. The avicularian cell is very large with a serrated edge: the mandible is triangular and acute.

The ovicells are typical, having the form characteristic of both species. Each ovicell is crowned by a sessile avicularium and has a large membranous area in front.

The collection contains some other specimens closely resembling the one already described, but in these the fornix has a small lamina equally developed on both sides of the stalk, while the mandible of the avicularium is longer.

It will thus be seen that the Lifu specimens resemble *Canda arachnoides* and differ from *Canda retiformis* in possessing avicularia and two spines on the upper margin (in Smitt's figures, most of the zooecia bear only one spine) whereas it differs from *Canda arachnoides* in the possession of a fornix and in the greater size of the avicularium.

4. *Scrupocellaria scrupea*, Busk. Busk, Brit. Mus. Cat., I. 24.

Only a few colonies occur.

5. *Scrupocellaria macandrei*, Busk. Busk, Brit. Mus. Cat. I. 24.

Only one small piece occurs.

6. *Scrupocellaria annectens*, MacGillivray. MacGill. Trans. Roy. Soc. Viet., 1886, p. 184.

There are two small, somewhat worn fragments which appear to belong to MacGillivray's species. They agree with it in the general character of the zoarium, the form of the zooecium and of its orifice, the character of the anterior avicularia, and in the absence of the fornix in sterile zooecia. Here as in *Scrupocellaria annectens*, there is a single vibraculum in the angle of bifurcation of the branch, and the anterior avicularium at the base of the zooecium lying at the point of bifurcation is larger than the others. The specimens differ from MacGillivray's species in possessing three spines at the external angle of all the cells in addition to the spine placed at the internal upper angle. The vibracula here seem to lie somewhat nearer the middle line, and the apex of the vibracular cell from which the seta projects, stands out as a prominent conical process. This feature is not shown in MacGillivray's figure. No lateral avicularia are seen on the specimens.

7. *Didymia triserialis*, n. sp. Pl. XLII., figs. 2 and 2 a.

Cells joined side to side, varying from four to twenty-eight in each internode, the ordinary zooecia being arranged biserially. At a bifurcation each cell of a primary pair gives off a secondary pair at its summit; ovicell smooth, imperforate, divided by curved lines into three areas, occupying about half the length of the cell, the orifice being a little above the centre; ooecial cells placed one above the other along the middle line of an internode interposed between the two lines of ordinary zooecia.

Measurements: *zoecia* from .69 mm. to .89 mm. in length \times .26 mm. in width.
ooecia .24 mm. \times .24 mm.

The position and structure of the ovicell are the characteristic features which differentiate this species from *Didymia simplex*, Busk, (Brit. Mus. Cat. i. p. 35). The ooecial cell does not occur at the bifurcation of a branch as in Busk's species, but in the middle line of an internode interposed between two ordinary zooecia, so that here the branch has three cells at the same level. There are several ovicells in an internode placed one above the other, and occasionally the fertile cells seem to be succeeded by an additional line of sterile zooecia so that the branch becomes triserial. This apparently occurs at the end of a branch only. The ooecial cell has the same structure as the other cells and does not present the peculiarities found in *Didymia simplex*.

8. *Bugula dentata*, Lamouroux. Busk, Brit. Mus. Cat., i. 46.

The zoarium is delicate and of a leaden blue colour. There are two spines at the upper inner angle, the lower one being the shorter; one spine at the upper outer angle, and two placed together further down on the outer side. All the spines point upwards except the last on the outer side which is directed inwards.

9. *Bugula avicularia*, Linnæus.

There is only one small fragment of this species.

10. *Bugula neritina*, Linnæus.

Growing on a Nautilus shell. Avicularia occur at the base of a few cells.

11. *Tubucellaria cereoides*, Ellis and Solander.

Very common.

12. *Cribilina radiata*, var. β , Hincks. Hincks, Brit. Mar. Pol., p. 185.

The zoarium forms a silvery white crust over *Terebratella* shells. The zooecia are oval and very minute (from .20 to .29 mm. in length \times .14 to .20 mm. in width). The ridges are not prominent; the interstitial pores are large. The central keel is inconspicuous; the small umbo below the mouth is most clearly seen in the fertile cells. The ordinary zooecia bear six spines round the mouth, the fertile cells two on each side. The ovicell has an indistinct keel. The avicularia occurring between the cells are elongate; vibraculoid appendages are wanting.

13. *Membranipora radicifera*, Hincks, var. *intermedia*, Kirkpatrick. Kirkpatrick, Sci. Proc. Roy. Dub. Soc., Vol. vi. p. 615.

The form of the spines characteristic of Kirkpatrick's variety is clearly seen in the young zooecia near the margin. On one side of the orifice is the spine bearing the avicularium, and the horizontal bifurcating branch spreading over the whole area. This limb bifurcates repeatedly, the ultimate branches being slender. On the opposite side there is a bifurcated spine of which the vertical branch is again bifurcated at

the tip; the horizontal limb is also deeply bifurcated and each branch so formed divides twice.

In some of the more central zooecia, some of the branches have met across the area; the fusion has however not progressed so far as in the typical *Hiantopora ferox*, MacGillivray, (*Membranipora radificera* var. *ferox*, Kirkpatrick) so that here we have an intermediate stage between the two varieties "*intermedia*" and "*ferox*."

15. *Membranipora irregularis*, d'Orbigny.

D'Orbigny, Voyage dans l'Amér. Mérid. VIII. 56.

This is fairly abundant, growing round Echinid spines.

17. *Membranipora punctigera*, Hincks. Ann. Mag. Nat. Hist. 5. VIII. 1881, p. 4.

One colony growing on a Nautilus shell. No ooecia present.

19. *Monoporella polymorpha*, n. sp. Pl. XLII., figs. 3 and 3 a.

Zoarium encrusting. Zooecia large, roughly hexagonal in shape, convex, rising slightly towards the orifice, separated by distinct lines; the surface in young cells covered with large opaque dots, these being obscured later by the growth of a brownish cuticular epitheca; below the orifice a little brown patch.

Measurements of zooecia 1·07 mm. to 1·34 mm. in length \times ·86 mm. to 1·12 mm in width.

Opercula calcareous, covered by a chitinous membrane.

Opercula of two kinds:

(1) the form occurring most frequently; arched above with a straight lower margin; bordered by a dark line, the greater part of the operculum being coloured brown leaving a light rim above.

Measurements: ·3 to ·34 mm. in width \times ·26 to ·28 mm. in length.

(2) not quite so numerous as the first; sides of the operculum sloping outwards from the straight lower margin; upper border drawn out into three lobes; here also a semi-circular brown patch occupying the larger part of the operculum.

Measurements: Width at base of operculum from ·3 to ·35 mm.

 " top " " ·42 to ·43 mm.

 Length " " ·32 to ·39 mm.

In the bays between the lobes of the operculum and also on the sides just below the lateral lobes are little circular scars, showing the presence of spines absent on zooecia bearing ordinary opercula. Rosette plates unusually large. Ooecium conical, with well marked ridges and deep grooves alternately radiating from the apex; from four to six indentations on the floor of each groove. Operculum of the fertile cell being of the more ordinary form, the upper margin arched, the lower straight or slightly curved inwards.

Measurements of ooecium ·96 mm. in width \times ·93 mm. in length.

This is a remarkable species being noticeable on account of its size and of the

occurrence of two kinds of zooecia. The one kind possesses opercula of an ordinary form and are without spines; the other are characterised by large lobed opercula and by the presence of spines in the bays between the lobes and on the sides of the orifice. In one zooecium there is a slight undulation in the operculum below the lateral spine so that this also lies in a bay; this seems to suggest that the bays may be due to a retardation of growth produced by the presence of spines.

No reason can at present be suggested for the existence of these two kinds of opercula. The zooecia contain similar polypides; those with the lobed operculum possess slightly stronger opercular muscles.

20. *Monoporella spinifera*, n. sp. Pl. XLII., fig. 4.

There are two small pieces.

Zooarium encrusting. Zooecia hexagonal, separated by depressed lines; surface covered with large pores; the intervening parts studded with minute nodules; orifice horse-shoe shaped, surmounted by ten short brown spines.

Operculum calcareous, covered with a brown chitinous membrane; horse-shoe shaped within the orifice, the distal wall of the zooecium raised into a shelf projecting into the cavity, the remaining space being closed in by a membranous diaphragm. There is one peculiar zooecium in which the diaphragm is calcified, two small holes being left for the opercular muscles. In this zooecium the orifice is drawn out into lobes between the spines.

Ooecia?

Measurements: *zooecium* 1.2 mm. in length \times 1.18 mm. in width; *operculum* .27 mm. in length \times .32 mm. in width.

21. *Schizoporella biaperta*, Michelin. Hincks, Brit. Mar. Pol. p. 255.

Fairly abundant.

22. *Schizoporella torquata*, Quoy and Gaimard.

Only one fragment.

23. *Schizoporella triangula*, Hincks. Pl. XLII., fig. 5. Hincks, Ann. Mag. Nat. Hist. (5) VIII. p. 12, 1881. Waters, Ann. Mag. Nat. Hist. (5) XX. 1887, p. 191.

The single specimen from New Britain seems on the whole to resemble Hincks' species, though it differs from it in some particulars. The surface is generally reticulo-punctate without nodules, except in some old zooecia where small nodules are found. The avicularia are placed on a small circular elevation from which lines pass to the sides of the orifice marking out a distinct raised area. These avicularia are not elongate but small and circular with a rounded mandible. However the form in this species seems to vary as in a specimen from Port Western, Melbourne, some avicularia are elongated while those on adjacent zooecia are rounded. The ooecium has a rough punctured surface, the older cells possessing also small nodules. The projecting processes and teeth on the margin of the ovicell described in Hincks' species are absent.

27. *Schizoporella depressa*, n. sp. Pl. XLII., fig. 6 and 6a.

Zoarium encrusting. Young zooecia ovate with a smooth surface; later the wall at some little distance from the orifice becomes thickened so that eventually the

orifice lies in the centre of a hexagonal depression surrounded by the thickened calcareous wall of the zooecium. Orifice arched above with a wide sinus below; at the junction of the two parts a minute denticle on each side.

On each side of the orifice in the young cell a minute oval avicularium placed on a small elevation; large vicarious avicularia with broad duck-bill shaped mandibles.

Ooecia?

Measurements of zooecium: .29 mm. in width \times .35 mm. in length.

32. *Lepralia feegeensis*, Busk. Pl. XLIII., fig. 7. Busk, Challenger Report, xxx. p. 144.

This species is abundantly represented in the collection. The opercula differ slightly from those of the Challenger specimens. In the latter, the lower margins of the opercula are straight or slightly curved inwards; the Lifu specimens have the lower margin slightly curved outwards forming an indistinct sinus.

Ooecia are plentiful; these do not occur on the *Challenger* specimens, and have, I believe, not been described. The ooecium is globular and depressed, occupying the greater part of the zooecium behind it. It is covered with large opaque granulations. The fertile cells bear no avicularia.

Measurements of the ooecium: .64 to .74 mm. in width \times .6 mm. in length.

33. *Lepralia poissonii*, Audouin.

There is only a tiny colony of this, growing over *Lepralia tuberculata* (n. sp.). The vibracula are placed at the side of the orifice in line with the upper margin. The vibraculoid mandibles are long, being equal to twice the length of the cell and lie parallel with one another.

34. *Lepralia tuberculata*, n. sp. Pl. XLIII., fig. 8.

Zoarium encrusting, in the form of a thick disc, the zooecia occurring only on the upper face. Zooecia contiguous, arranged in radiating rows which become less regular towards the centre; cells rising towards the orifice giving the zoarium an uneven surface; surface of the individual zooecium smooth and shining; above the orifice eight marginal spines. Operculum orbicular or slightly coarctate with a rounded lower border. On each zooecium placed at the sides of the orifice, two elongated avicularia with blunt spatulate mandibles directed upwards; numerous large vicarious avicularia with duck-bill shaped mandibles. Ooecium globular, sub-cucullate, smooth, reaching as far back as the orifice of the cell behind.

Measurements:

zooecium .3 to .36 mm. in width \times .32 to .42 mm. in length.

operculum .1 mm. \times .1 mm.

ooecium .18 mm. in width \times .15 mm. in length.

There is only one colony of this species.

35. *Lepralia calyciformis*, n. sp. Pl. XLIII., figs. 9 and 9 a.

Zoarium unilaminar and cup-shaped, being attached at the base; zooecia occurring

in rows radiating from the centre and being separated by depressed lines marked by small indentations; surface smooth and shining. Orifice sub-central, surmounted by eight spines. Operculum coarctate with an arched upper margin and a slightly convex lower margin. Placed far back on each side of the orifice a minute avicularium on a small elevation, mandible rounded, and directed inwards and upwards. Distributed over the zoarium, other minute oval avicularia with rounded mandibles.

Ooecia ?

Measurements: *zoecium* .32 mm. in width \times .31 mm. in length. *operculum* .08 mm. in width \times .11 mm. in length.

This species which is here represented by a single colony also occurs in the collection from Torres Straits which Dr Haddon has presented to the Cambridge University Museum of Zoology. It bears a superficial resemblance to *Lepralia tuberculata*, the species described above, but is distinguished from it by the shape of the zoarium, the size and shape of the opercula and the form of the avicularia.

36. *Smittia marmorea*, Hincks. Pl. XLIII., fig. 10. Hincks, Brit. Mar. Pol., p. 350.

The collection contains one small fragment which seems to correspond with Hincks' species. The sinus in the lower margin of the secondary orifice is broad and the notches on each side are very prominent. The pores at the edge are very large and the avicularia are longer than in Hincks' species, extending the whole length of the zoecium.

No ooecia are seen on this fragment.

37. *Mucronella articulata*, n. sp. Pl. XLIII., fig. 11.

Zoarium disc-shaped and encrusting. Zooecia arranged in lines, the cells being indistinctly separated from one another; the surface finely granular. Orifice orbicular and below it a small mucro; round the orifice eight long jointed spines standing up vertically; each spine consisting of three joints, the terminal segment ending in an expanded funnel. Placed high up, one on each side of the orifice in the younger zooecia, two minute avicularia with rounded mandible directed inwards. Distributed over the zoarium, large vicarious immersed avicularia with broad duck-bill shaped mandibles.

Ooecia ?

Measurements: *zoecium* .42 mm. in width \times .26 mm. in length. *operculum* .1 mm. \times .1 mm.

The characteristic feature of this species is the presence of jointed spines with the terminal segment expanded into a funnel. In most of the central zooecia only the two lateral spines have this cup-like termination, the remaining six being shorter and possessing ends which are not expanded but often pointed. However the fact that most of the marginal zooecia possess *eight* spines with expanded ends suggests that the others have lost their terminal joint.

There are three colonies of this species.

38. *Rhynchozoon bispinosum*, Johnston. Hincks, Brit. Mar. Pol. p. 385.

The mucro is small and no spines are visible even on the marginal cells.

39. *Rhynchozoon crenulatum*, Waters. *Rhynchopora crenulata*, Waters, Ann. Mag. Nat. Hist., 5, xx. 1887, 195.

There is only one colony of this species.

40. *Escharoides spinigera*, n. sp. Pl. XLIII., fig. 12.

One small encrusting colony.

Zooecia ovate, surface smooth and polished. Primary orifice sub-orbicular with an entire margin; above the orifice eight spines; the secondary orifice with a sinus on one side of the lower margin; on the inner side of the peristome directed towards the sinus a minute avicularium with a bluntly pointed mandible; on some zooecia, placed by the side of the orifice, an avicularium with a spatulate mandible directed upwards.

Ooecia?

Measurements: *zooecium* from .29 to .37 mm. in width \times .30 to .43 mm. in length, *operculum* .06 mm. \times .08 mm.

The avicularium on the inner side of the peristome is visible in only a few cells.

41. *Cellepora simplex*, MacGillivray. McCoy. Prodr. Zool. Vict. p. 241, pl. 165.

A common species in Lifu.

44. *Cellepora longirostris*, MacGillivray. Pl. XLIII., figs. 15, 15 a. MacGill., Trans. Roy. Soc. Vict. 1884, p. 113.

The collection contains two fragments which appear to belong to this species. Both are encrusting, but from the centre of one there projects a short process which suggests that the specimen may be simply the encrusting base of an erect colony—the erect habit being characteristic of *Cellepora longirostris*. The young zooecial stages described by MacGillivray are clearly seen on the margin of the specimens. The orifice has a rounded sinus, and on one side is the small avicularium which is later concealed by the growth of the peristome. The opposite edges of the latter arch over the sinus and form a rounded opening which is subsequently filled in. Finally there grows up from the sub-oral part of the peristome an enormously developed rostrum, the free apical part of which is, as a rule, coarsely serrated. The rostrum has a thick base, and generally bears on its outer face an elongated avicularium directed downwards. The unusual size of the rostrum is a striking characteristic of the Lifu specimens. The ovicell is globular, and is almost concealed by the peristome. The front is sculptured in a radiate manner.

45. *Retepora phoenicea*, Busk. Busk, Brit. Mus. Cat. II. 94. Busk, Challenger Report, xxx. 124.

This species is plentiful in Lifu.

46. *Retepora denticulata*, Busk. Pl. XLIII., fig. 13. Busk, Challenger Report, xxx. 109.

The dorsal avicularia seem to be more numerous than on the Challenger specimens. They occur laterally on the dorsal surface and on the trabeculae connecting the branches. The beak is bluntly pointed and is bent up at the end; the mandible is triangular with a broad base; the pointed apex is bent down. The ooecia in many respects resemble those of *Retepora apiculata* (Busk, *Challenger Report*, xxx. 108). They are globular, smooth and sub-cucullate. There is a median grooved keel on each side of which there is a slight longitudinal depression. The upper lip of the opening is trifid.

47. *Crisia aculeata*, Hassall. Hincks, Brit. Mar. Pol. p. 421. Hassall, Ann. Mag. Nat. Hist. (5) VII. 368. Harmer, Q. J. M. S. 1891, p. 132.

There is one small colony growing on a sea-weed. In the absence of an ovicell, it may provisionally be referred to this species.

48. *Crisia denticulata*, Lamk. Hincks, Brit. Mar. Pol., p. 422.

There are several colonies growing on a large crab. No ovicells are present on the specimens.

50. *Idmonea interjuncta*, MacGillivray. MacGill. Trans. Roy. Soc. Vict. 1885, p. 137. Common.

51. *Idmonea radians*, Lamarek. Busk, Brit. Mus. Cat. III. 11.
Very common.

52. *Idmonea australis*, MacGillivray. McCoy, Prodr. Zool. Vict. I. Pl. 68, p. 30.
Several rather young colonies.

53. *Entalophora delicatula*, Busk.
Pustulopora delicatula, Busk, Brit. Mus. Cat. III. 20.
Several small colonies.

54. *Hornera spinigera*, Kirkpatrick. Kirkpatr., Ann. Mag. Nat. Hist. 6, I. 1888, 83.
One large fine colony.

59. *Lichenopora californica*, D'Orb.
Discoporella californica. Busk, Brit. Mus. Cat. III. p. 32.
One small colony growing on a Nautilus shell.

60. *Lichenopora truncata*, n. sp. Pl. XLIII., figs. 14 and 14 a.

Zoarium convex, flattened on the top; shaped like a truncated cone, bordered by a thin lamina; central flattened area occupied by cancelli. Zooecia arranged in long uniserial rows of almost equal length, there being about fifteen zooecia in a row in the type specimen. Zooecia not raised above the surface. Orifice circular, the peristome being produced on the upper side; margin of the peristome entire or slightly

produced at the angles; between the zooecial rows four series of cancelli which are not denticulate; those belonging to the two central rows of each interspace as large as the orifices of the zooecia, the lateral cancelli being smaller.

The colony is about 5 mm. in diameter. Two specimens only occur in the collection.

61. *Radiopora cristata*, Busk. Busk, Brit. Mus. Cat., III. 35.

There are numerous fine colonies of this species.

62. *Fasciculipora carinata*, Ortmann. Ortmann, "Jap. Bryo. Fauna." Arch. f. Naturg., 56, I. 1890, p. 65.

One colony.

63. *Zoobotryon pellucidum*, Ehrenberg. Reichert, Abh. k. Akad. Berlin, 1869. II.

These specimens differ slightly from the Mediterranean species in the arrangement of the zooecia. Here the individuals are more crowded at the ends of the branches, while there are longer spaces devoid of zooecia on the main branch. Otherwise the characters seem to be those of Ehrenberg's species.

EXPLANATION OF PLATES XLII AND XLIII.

All the figures were drawn by means of a camera lucida; figs. 1, 5, 6, 8, 9, 10, 11, 12 and 13 with a Crouch objective A with front lens on; figs. 2 and 2 a, 3 and 3 a, 4, 7 and 14 with Crouch objective A with front lens off. All the figures were then reduced by one half.

FIG. 1. *Canda retiformis*, Pourtalès.

FIG. 2 and 2 a. *Didymia triserialis*, n. sp.

FIG. 3 and 3 a. *Monoporella polymorpha*, n. sp.

FIG. 4. *Monoporella spinifera*, n. sp.

FIG. 5. *Schizoporella triangula*, Hincks.

FIG. 6. *Schizoporella depressa*, n. sp.

„ 6 a. Young zooecia of same.

FIG. 7. *Lepralia feegeensis*, Busk, showing ovicell.

FIG. 8. *Lepralia tuberculata*, n. sp.

FIG. 9. *Lepralia calyciformis*, n. sp.

„ 9 a. Colony of same, four times natural size.

FIG. 10. *Smittia marmorea*, Hincks.

FIG. 11. *Mucronella articulata*, n. sp.

FIG. 12. *Escharoides spinigera*, n. sp.

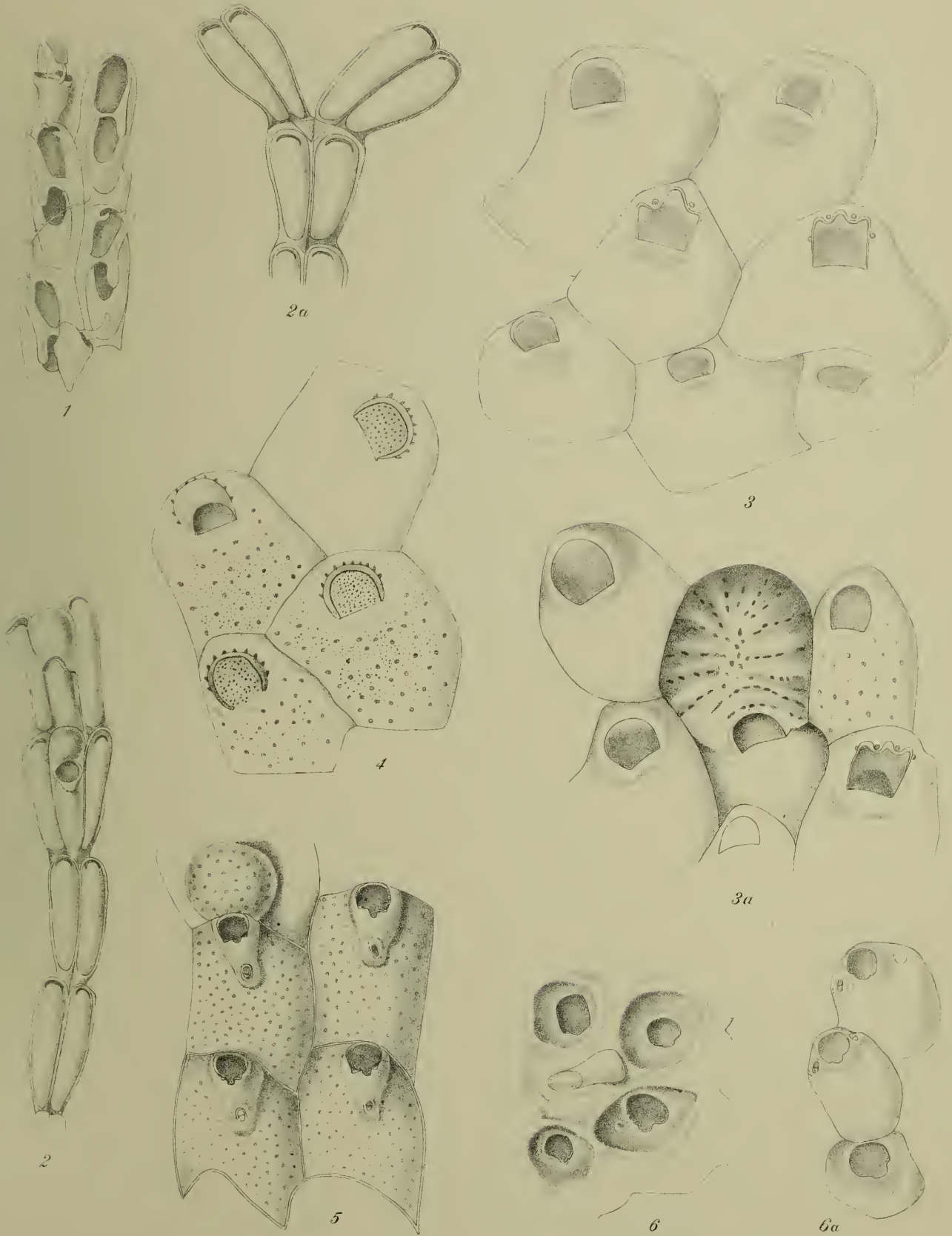
FIG. 13. Ovicells of *Retepora denticulata*, Busk.

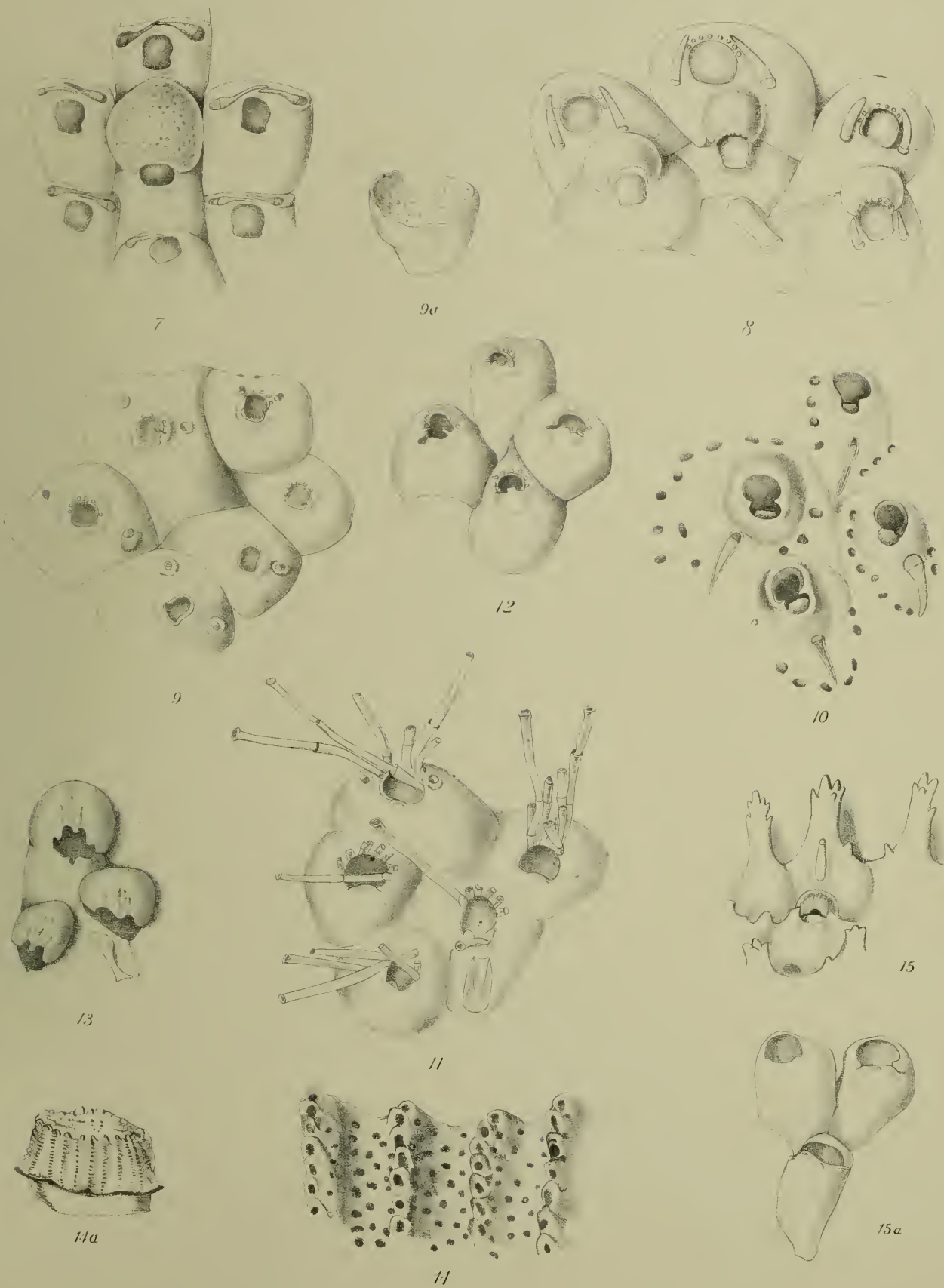
FIG. 14. *Lichenopora truncata*, n. sp. Part of a colony seen from the side.

„ 14 a. Colony of same, four times natural size.

FIG. 15. *Cellepora longirostris*, MacGill. The rostrum below the ovicell has been broken off.

„ 15 a. Young zooecia of same.





THE HYDROID ZOOPHYTES COLLECTED BY DR WILLEY IN THE SOUTHERN SEAS.

By LAURA ROSCOE THORNELY,

University College, Liverpool.

With Plate XLIV.

THE Hydroids in this collection, though many of them are broken from their colonies in a tantalizing way, were evidently so full of life when gathered, and are so beautifully preserved, that to the smallest details they have been interesting to examine. Of two or three species, as I have noted under the descriptions of them, there are considerable quantities; of others, few, but complete, colonies; and of several too little to allow me to do more than identify the genus to which they belong. Of these last there is a *Cryptolaria*, probably *C. pulchella* Allman, a *Eudendrium*, a *Lafoea*, two *Thuiarians*, an *Ophiodes*, and a *Sertularella*, probably *S. angulosa*.

I am much indebted to Dr Willey for trusting me with his specimens, and I should like to offer my very best thanks to Professor Herdman, D.Sc., F.R.S., for his very great help with advice and with books.

FAMILY. ATRACTYLIDÆ, Hincks.

GENUS. *Hydranthea*, Hincks.

Hydranthea australis, n. sp.

There are several little colonies of this species creeping over other zoophytes. The stem is very short, enclosed at the base in little cup-like extensions of the polypary, as in *Hydranthea margarica*, Hincks¹, which also has numerous tentacles in a single verticil and large gonophores like this species. The tubercles of thread cells at the base of the tentacles, and the four branched vessels in the gonophore, characteristics of *Hydranthea*, are not visible in these specimens, but the whole appearance points to the species being of this genus and closely related to *H. margarica*.

¹ *British Hydroid Zoophytes*, 1868, p. 100.

The position of the gonophore, rising from the side of the cup of the hydrotheca, instead of from the stolon and within a cup of its own, is the only marked difference which makes it necessary to separate the species.

LOCALITY. Blanche Bay, New Britain; growing among other zoophytes attached to ropes and fish-baskets down to 40 fathoms.

GENUS. *Bougainvillia*, Lesson.

Bougainvillia muscus Allman, Pl. XLIV. Figs. 2, 2a, 2b.

There are colonies of this *Bougainvillia* covering the cast spines of a *Cidaris*. They are taller than the description of *B. muscus*, as described by Hincks¹, corresponding thus more with his form intermediate between that species and *B. ramosa*, but they have not the compound stem of this form though they have the sanded polypary.

These colonies have gonophores (Fig. 2b) borne on the stem, some way below the polypites, two or three together on a branched offshoot.

From a separate collection taken from ropes and fish-baskets and floats there are also some colonies which are shorter and have curious tendrils, some simple, some branched (Fig. 2a), and of varying lengths, attached to the stems below the polypites.

The characters in both these sets of specimens do not seem sufficiently marked to justify the formation of a species apart from *Bougainvillia muscus* Allman.

LOCALITY. Blanche Bay, New Britain.

FAMILY. TUBULARIIDÆ, Hincks.

GENUS. *Ectopleura*, L. Agassiz.

Ectopleura pacifica, n. sp., Pl. XLIV. Figs. 1, 1a.

Of this fine species there are a profusion of colonies, detached from floats, fish-baskets, &c. The stems are simple, unringed, diminishing in width towards the base and about 2 cm. high, rising from a creeping stolon which connects the colony. There are some processes given off from the stem near the base in many of the specimens which probably help to attach the colonies to the objects they grow upon. The polypite is abruptly marked off from the supporting stalk. The tentacles are disposed in two verticils of from 18—20 each. The distal tentacles appear to be not wholly filiform (see Fig. 1), but this may be the effect of contraction of the preserved specimen.

The gonophores are borne in clusters of from seven to nine on branched peduncles which spring from the body of the polypite, between the two sets of tentacles. The most highly developed among them have two long tentacles (Fig. 1a), and there are indications of what may be the eight longitudinal ribs formed of the linear series of thread cells found in the genus *Ectopleura*. The above species is quite distinct from the only other *Ectopleura*, *E. dumortierii*, Van Beneden.

LOCALITY. Blanche Bay, New Britain.

¹ *British Hydroid Zoophytes*, 1868, p. 111.

FAMILY. CAMPANULARIIDAE, Hincks.

GENUS. *Obelia*, Peron et Lesueur.*Obelia linearis*, n. sp., Pl. XLIV. Fig. 6.

There are only two little rooted specimens of this species, 7 mm. in height. The stem is simple, horn-coloured below, transparent above, and is branched (see Fig. 6).

The hydrothecae are deep, their margins have about twelve blunted teeth around them. There are usually longitudinal lines to be seen on the hydrothecae, the result probably of the collapsing of their delicate sides.

The gonothecae are borne in the axils of the peduncles, they are elongate oval, smooth, and with a prominent rim to the orifice.

The gonozooids seen within the gonothecae show signs of tentacles in those that are uppermost in the gonothecae.

LOCALITY. Blanche Bay, New Britain.

Obelia delicatula, n. sp., Pl. XLIV. Fig. 7.

This is a smaller, more delicate form than the last, and unbranched, but the hydrothecae and gonothecae are much the same in their characters.

The stem reaches 4 mm. in height, borne on a creeping stolon, which carries the gonothecae also.

The stems are ringed at their bases, and here and there above, and are also several times ringed under the hydrothecae (Fig. 7). The whole colony has much the appearance of *Campanularia phycocyathus*, Allman¹, but the zooids in the gonothecae show the budding tentacles of the free swimming medusoid, showing that it does not belong to that genus.

LOCALITY. Blanche Bay, New Britain, 40 fathoms.

Obelia serrulata, Bale (sp.), Pl. XLIV. Fig. 5.

The largest piece among the fragments collected of this species is a little over 1 cm. in height. It is branched and has a strong compound stem formed by the downward growth of stolons from the peduncles of the hydrothecae.

The hydrothecae are very broad above, tapering downwards towards the base. The floor is raised above the base so as to leave a large cavity beneath it, and this character, together with that of the marginal teeth, agrees with Mr Bales'² description of *Campanularia? serrulata*, Bale, found at Port Jackson. His specimens were delicate, and there being no gonothecae present makes it appear likely that they were immature.

The gonotheca of the present species is oval, truncated above, and borne on the stem, and contains zooids with budding tentacles (Fig. 5).

LOCALITY. Blanche Bay, New Britain: from ropes and fish-baskets in 40 fathoms.

¹ *Voyage of H.M.S. Challenger, Report on the Hydroids*, Pt II.

² *Proc. Linn. Soc. New South Wales*, Vol. III. 1888, p. 757.

GENUS. *Campanularia*, Lamouroux (in part).

Campanularia brevithecata, n. sp., Pl. XLIV. Fig. 8, 8a, 8b.

This form has a simple, unbranched stem, a little more than 1 cm. in length, very slender, with several rings at the base (Fig. 8a) and one or two at intervals up the stem, while directly below the hydrotheca there is one spherical ring as in *Campanularia volubilis*, Linnaeus.

The hydrotheca is extremely short, so as only to cover about one-third of the polypite when it is extended, and has an even rim (Fig. 8).

The polypite has about twenty tentacles, and a remarkably large trumpet-shaped proboscis, suggestive of a *Eudendrium* from which the species is widely separated by its other characters.

The gonothecae (Fig. 8b) present rise from the stolon on short pedicels, and have the appearance of those of *Campanularia caliculata*, Hincks, as figured by Hincks¹, and contain one or two large sporosacs with four gastro-vascular canals to each.

C. caliculata Hincks, as figured by Mr Bale², has much the appearance of my specimen, but without the polypite the proportional sizes of polypite and calycle are not obvious. In some of Mr Bale's specimens from Port Jackson the calyces have not the thickened wall usual in *C. caliculata*, which would bring it nearer to our form, but there are still sufficient grounds for considering this a new species on account of the smallness of the theca and the largeness of the polypite proboscis.

LOCALITY. Blanche Bay, New Britain, one colony covering the body of a *Lepas*, others detached from ropes and fish-baskets.

GENUS. *Gonothyrea*, Allman.

Gonothyrea longicyatha, n. sp., Pl. XLIV. Fig. 4, 4a.

There are a large number of complete colonies of this strikingly pretty form. Their height is about 3 cm., they are much branched, the main stem is deep brown in colour, and offshoots from the bases of the pedicels of the hydrotheca, growing downwards, form a strong compound stem (Fig. 4a), as described by Dr Hartlaub³ for *Obelaria gelatinosa*, and by Mr Bale⁴ for *Obelia? spinulosa*.

The hydrothecae are remarkably long and narrow, and the castellations on their rims so deeply grooved as to make sharp, needle-like points of their edges (see Fig. 4).

The gonothecae are very numerous, borne on short ringed pedicels in the axils of the branches. They are oval and truncated at the top. In nearly all cases they are flattened laterally, which makes the top fall in, forming a groove, but this is probably a result of the preservation of a delicate form.

¹ *British Hydroid Zoophytes*, 1868, Pl. 31, Fig. 2 d.

² *Proc. Linn. Soc. New South Wales*, Vol. III. 1888, p. 755.

³ *Meeresfauna von Helgoland 1897, Zweiter Bericht*, Kiel.

⁴ *Proc. Linn. Soc. New South Wales*, Vol. III. p. 756.

I have only seen one external capsule, and that is not perfect, but unfolding tentacles can be seen on the uppermost sporosac in several of the gonothecae.

This description agrees with that of *Gonothyræa hyalina*, Hincks¹, to some extent, but here there is the fascicled stem, and the hydrothecae, as well as the points on their turrets, are more drawn out, while their total size is less. If what appears to be an external capsule is in reality an escaping medusiform zooid, the species may be an *Obelia*.

Obelia longicyatha, Allman², is like the present species in the shape of the hydrothecae, but not in that of the teeth on their margins. *Campanularia? spinulosa*, Bale³, agrees in the shape of the hydrotheca and its teeth and in the polysiphonic stem, and as gonothecae have not been found for this form it is possibly this species. From the description by Mr Clarke of *Obelia bidentata*⁴ it is evidently a much larger species than this.

LOCALITY. Blanche Bay, New Britain: from floats and ropes attached to fish-baskets, some from a depth of 50 fathoms.

FAMILY. SERTULARIIDAE, Hincks.

GENUS. *Sertularia*, Linné (in part).

Sertularia pusilla, n. sp.

This is a minute species, only 3 mm. in height, and looking in all ways only half the size of the *Pasythea quadridentata*, Ellis and Sol., amongst which it is growing.

The opposite hydrothecae join each other in front and are separated behind. They are very long and slender, and delicate looking, as are the internodes which bear these one pair on each. The polypites show almost black through the transparent polypary.

LOCALITY. Lifu, Loyalty Islands.

Sertularia littoralis, n. sp.

There are several specimens of a little *Sertularia* of a bright brown colour, looking like *S. pumila*, Linnaeus. They are smaller than that form, however, being only 7 mm. in height, and with the branches in the one specimen that has any, alternate instead of opposite. These are placed on the internodes, below the hydrothecae of three successive internodes, beginning on the third from the base. The hydrothecae are

¹ *British Hydroid Zoophytes*, 1868, p. 184.

² "Report on the hydroids collected during the exploration of the Gulf Stream," by L. F. de Pourtalès. *Memoirs Museum of Comparative Zoology, Harvard University*, Vol. v. (1877), p. 10.

³ *Proc. Linn. Soc. New South Wales*, Vol. III. 1888, p. 756.

⁴ "Description of new and rare Hydroids from the New England coast." *Transactions of the Connecticut Academy of Arts and Sciences*, Vol. III. Pt. 1.

opposite in all cases, and there are none in the axils of the branches. They are in contact with each other in front, separated behind, and have a horizontal fold crossing the cell as in *S. loculosa*, Busk.

There are no gonothecae.

LOCALITY. Lifu, Loyalty Islands; littoral.

GENUS. *Pasythea*, Lamouroux.

Pasythea quadridentata, Ellis and Solander. Nat. Hist. of Zoophytes, London, 1786. There are a few fragments of this species.

LOCALITY. Lifu, Loyalty Islands.

FAMILY. PLUMULARIIDAE, Hincks.

GENUS. *Aglaophenia*, Lamouroux (in part).

Aglaophenia bellis, n. sp.

This species has almost the exact appearance of Professor Allman's¹ figure of *Aglaophenia Macgillivrayi*, Busk (sp.), and most of its details correspond with his description of them, but there are a few marked differences which I think make a separation necessary.

There is the fascicled stem with opposite pinnae as in *A. Macgillivrayi*, giving off secondary alternate pinnae which carry the hydrothecae, and there are branches taking the places of pinnae at irregular intervals and resembling the stem in structure. It is remarkable in this species the thickness of even the pinnae, the hydrothecae bearing pinnae, forming merely a feathered line up the middle of a thick "woody" stem, which is spotted by the lateral communications between its tubes spoken of by Professor Allman² as a characteristic of this group.

The hydrothecae have the same intrathecal ridge as in *A. Macgillivrayi*, the mesial sarcothecae are adnate for their whole length, the same height as the hydrothecae, bithalamic and canaliculate, and the lateral sarcothecae correspond, but I cannot see the intracauline ridges, and the margins of the hydrothecae have a little projecting point on either side.

The corbula is closed, with about eight series of costae, but there is no spur-like sarcotheca at the base, nor cup at the summit of each costa which give so striking an appearance to Professor Allman's figure of the corbula in *A. Macgillivrayi*.

Viewed from the front my corbulae show that the ribs are disjointed in the middle, the two halves rise from different points at their bases and do not therefore meet above. This form would agree with Professor Allman's³ idea that these corbulae

¹ *Voyage of the 'Rattlesnake,'* Vol. I. 1852, p. 400.

² *Voyage of H.M.S. Challenger*, Pt 1, 1883, p. 5.

³ *Ibid.*, Pt. I. p. 11.

are formed of the mesial sarcothecae of a hydrocladium or ultimate pinna, which, deprived of their hydrothecae and lateral sarcothecae, are thrown off to left and right alternately up the pinna, giving off secondary sarcothecae which continue the ribs upwards. The position of the corbula taking the place of a hydrotheca bearing pinna and the number of the costae corresponding with the number of hydrothecae on these pinnae, allowing for the one complete hydrotheca which is always present below the corbula in these specimens, makes it seem natural that the corbulae are formed thus.

There are only a few species known of *Aglaophenia* which have the doubly pinnate ramification and the bithalamic form of mesial sarcotheca, and *A. Macgillivrayi* is the only representative in Australian seas.

LOCALITY. Engineer group, British New Guinea.

GENUS. *Plumularia*, Lamarck (in part).

Plumularia compacta, n. sp., Pl. XLIV. Fig. 3.

A good large quantity of this species was found. The colonies resemble the description by Mr Bale¹ of a small variety of *Plumularia setaceoides*, Bale². They are pale horn colour, unbranched, 1.5 cm. in height. The pinnae are alternate and bear four hydrothecae at most, which have even rims and a mesial and two lateral sarcothecae, while there is also a sarcotheca on an internode between every two hydrotheca-bearing internodes and one on the lower part of each stem internode.

The gonothecae grow near the bases of the stems, below the pinna-bearing internodes. They differ from those of *P. setaceoides*, which are obliquely truncated a little above the broadest part, in tapering upwards from the broadest part about as much as they taper downwards below it and in terminating with a neat rim. These gonothecae show clearly that this is not Mr Bale's *P. setaceoides*: it may be what he described as a smaller variety, in which he found no gonothecae, but in that case it must become the independent species—which I have described above as *P. compacta*.

LOCALITY. New Caledonia.

¹ *Catalogue of the Australian Hydroids*, 1884.

² *Journ. Mic. Soc. Vict.*, II. (fig.).

EXPLANATION OF PLATE XLIV.

- FIG. 1. *Ectopleura pacifica*, n. sp.
,, 1 a. The gonophores.
- FIG. 2. *Bougainvillia muscus*, Allman.
,, 2 a. Tendrils.
,, 2 b. Gonophore.
- FIG. 3. *Plumularia compacta*, n. sp.
- FIG. 4. *Gonothyraea longicyatha*, n. sp.
,, 4 a. The stem showing the downward growth of the stolon.
- FIG. 5. *Obelia serrulata*, Bale (sp.)
- FIG. 6. ,, *linearis*, n. sp.
- FIG. 7. ,, *delicatula*, n. sp.
- FIG. 8. *Campanularia brevithecata*, n. sp.
,, 8 a. Base of the stem.
,, 8 b. The gonotheca.



THORNELY HYDROIDS.

West, Newman lith.

ASTROSCLERA WILLEYANA,

THE TYPE OF A NEW FAMILY OF SPONGES.

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University of Cambridge.*

With Plates XLV—XLVIII, and three Figures in the text.

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IN the collections brought home by Dr Willey from the Western Pacific were four specimens of a peculiar hard white organism which he found growing on dead coral, at a depth of 35 fathoms, in Sandal Bay, Lifu, Loyalty Islands. These he placed in my hands for examination. A short account of the results I had arrived at was given at the meeting of the British Association at Dover in September, 1899. As the organism appeared to be new, the name *Astrosclera willeyana* was proposed

for it¹. In November I received from Mr Kirkpatrick of the British Museum another specimen of the same or a closely allied organism, which was collected in the boring expedition to Funafuti, one of the Ellice Islands lying about a thousand miles to the N.E. of Lifu. This was obtained at the depth of 100 fathoms on the outer slope of the western side of the island.

Before proceeding to details it may be stated that the hard parts consist of solid polyhedral elements united to form a continuous skeleton. This is penetrated by canals which branch and anastomose freely, and open to the exterior by apertures on the upper surface. The canals are occupied by soft tissues which also cover the upper surface, and are continued for some distance down the sides.

External Characters. The *Lifu* specimens are cylindrical in shape, and measure about 10 mm. in height and 5 mm. in breadth. The base is slightly spreading, the sides smooth and imperforate, and faintly marked by annular constrictions, and the upper surface gently convex. In three of the specimens the growth has occurred at right angles to the surface of attachment (Fig. 1), but in the fourth (Fig. 2), whose attachment appears to have been to a vertical surface, the axis is curved. The rounded *upper surface* is closely pitted by the openings of the canal system, those at the periphery being smaller than the others.

In three of the specimens the openings are disposed indefinitely (Fig. 2 *a*), but in the fourth (Fig. 1 *a*) there is a somewhat different arrangement. The upper surface of this specimen is oval in outline, and about a point nearer one end of the long axis than the other some seven grooves are disposed in a radiate manner. The grooves show a tendency to branch at their outer ends, before they are lost in the irregularities of the surface; and one of them, which lies in the long axis, gives rise to two subsidiary grooves which however are not disposed symmetrically about it. The openings of the canal system are to be seen in the floors of the grooves as well as on the parts of the upper surface lying between them. The soft tissues here cover the surface, and it is not obvious that the pores in the grooves, or at the centre from which they radiate, are larger than the others. A comparison of it with the Funafuti specimen, however, renders the existence of larger pores in these situations not improbable. The grooves are probably the initial stages of radially disposed canals.

The specimen from *Funafuti* (Fig. A, 1—5) has grown attached by a short stalk (A, 1, *st.*) about 6 mm. wide at the base, which expands into a broad, nearly circular disc (*d—d*), convex above, and resembling the pileus of a mushroom in shape. The diameter of the disc is about 20 mm., and the distance from the broken end of the stalk to the centre of the upper surface of the disc is 16 mm.

A smooth, imperforated, cortical layer covers the outer surface of the stalk and under surface of the disc, and presents concentric ridges and grooves, marking lines of growth (A, 2). The upper surface of the disc is in part perforated by pores, whose arrangement is described below.

There appears to have been an interruption to the growth of the specimen after the formation of the disc, and the later extension has taken place not uniformly, but

¹ The definition of the species, i.e. of the family which it constitutes, is here given for the first time, p. 479.

only from parts of its upper surface. At these parts rounded bosses of different sizes have been formed (Fig. A, 1, and 2, *b, b*), and they, like the original disc, are perforated by pores on their convex upper surfaces and covered on the sides by an imperforate

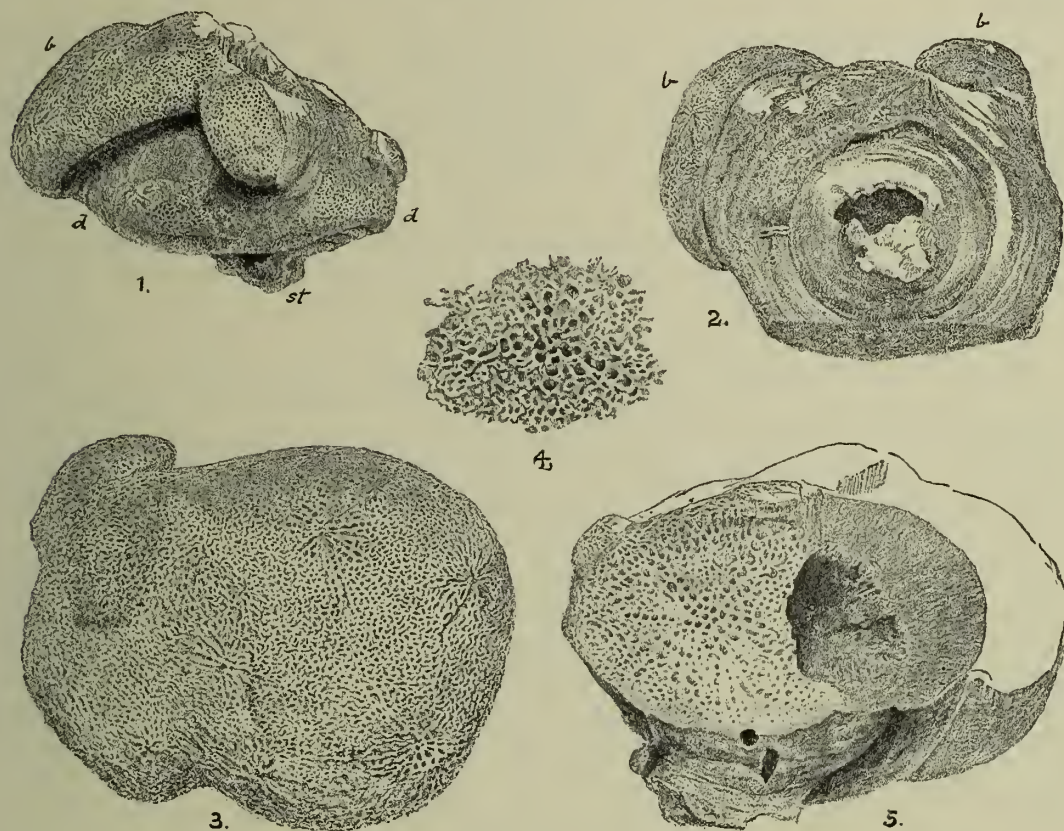


FIG. A. THE FUNAFUTI SPECIMEN OF ASTROSLERA.

b, b. The bosses formed by later growth. *d, d*. The disc-shaped expansion of the original growth. *st*. The stalk of attachment.

1. Side view.
2. View from the base, with the stalk turned towards the spectator. Part of the specimen has been cut away, and the base has been excavated by some boring organism.
3. View of the surface of the large bosses formed by later growth.
4. One of the radiate systems of large pores more highly magnified.
5. View of the cut surface of the original growth, showing the radiate arrangement of the large canals in the interior.

cortical layer, which in some places appears to have spread from their base over the adjoining regions of the surface of the original disc.

The growth of the bosses repeats the character of that of the original disc, expanding from the base; and the greater mass of the new growth appears to have been formed by the fusion of three originally distinct bosses.

It is further to be observed that the trend of growth of the later formed bosses is in a direction deflected at an angle of about 60° from the axis of the original growth. We may conjecture that this result has been produced by the shifting of the position of the object—block of coral or what-not—to which the specimen was attached.

The upper surface, whether of the original disc or of the later formed bosses, is perforated by closely set pores (Fig. A, 3 and 4). These are sometimes isolated, but often they open into curving and branching grooves, recalling those of the coral *Maeandrina*. At seven places on the surface of the later growth, and at one on the original growth, the lines of pores are seen to be disposed in a radiating manner about so many centres. The lines about a centre vary in number from five to ten, and at their outer ends they become lost among the smaller pores round about. The pores along these lines are large (Fig. A, 4), being at least twice the diameter of those distributed elsewhere over the surface, and a group of such pores is situated at each of the centres from which the lines radiate.

There is then a differentiation of the pores, and hence of the canals, whose openings they are, into two categories, viz. large ones disposed in radiating systems, and small ones distributed between the systems. As will be seen later, the distribution of the pores at the surface is the expression of an arrangement of the canals found throughout the interior.

The soft parts proper to the organism were not present in the portions of this specimen that I have decalcified, and a boring sponge, with characteristic pin-shaped siliceous spicules and bundles of *raphides*, appears in the sections. Moreover, the surface even of the most recently formed part is dotted over with the pink growths of the Foraminiferan *Polytrema*, a brown alga has established itself at one point (these have been omitted in the figures), and the base has been much excavated by boring organisms. It appears, therefore, that this specimen of *Astrosclera* had died some time before it was collected.

Methods. When collected by Dr Willey the Lifu specimens were put into strong alcohol (over 70 %). In examining them two have been decalcified by means of dilute acetic acid, added drop by drop to a dish of 70 % alcohol containing them, until bubbles of gas appeared. When decalcification was completed, the soft organic body was divided longitudinally, and the parts embedded in paraffin and cut into sections—one half into longitudinal sections, the other into transverse. Another specimen was dealt with as follows. It was first divided longitudinally by a fret-saw, to allow the reagents to penetrate the interior more readily. Some idea of the degree of hardness of the skeleton may be gained from the fact that the lines of the sawing were sharply marked on the cut surfaces. On the other hand, it was not so hard as to perceptibly blunt the saw, a result which was soon effected by the skeleton of a specimen of *Polytrema*, on which I made a preliminary experiment. The upper part of one half of the specimen was sawn off, decalcified, and cut into sections, for comparison with the sections of the other specimens. The remaining parts were then stained in borax carmine for two days, passed through 90 % and absolute alcohol into chloroform, and

then placed in an open dish in a thin solution of gum copal in chloroform. After some days, when the solution had become thick, the specimens were put on slides, with the thickened gum about them, and placed on the shelf of the warm water bath (60° C.) to harden. When the gum was hard, slices of them were cut with the fret-saw, one half being cut longitudinally, the other transversely. Each furnished three slices.

One surface of the slice was ground down smooth on a hone, and it was then cemented to a slide with Canada balsam, with this surface downwards. When the balsam was hard, the other surface of the slice was ground down until the section was so thin that the edge began to break. It was then dried and covered with Canada balsam and a coverslip.

This method is that of von Koch, as given in Bolles Lee's *Vade-mecum*. It may be worth while to mention that in grinding the sections, lumps of ice were kept on the hone in order that the copal (which is soft at 60° C.) might be as hard as possible.

The structure of the hard and soft parts is well displayed in these preparations.

The fourth Lifu specimen I have kept intact.

Slices both vertical and tangential to the most recently formed part of the surface of the Funafuti specimen, have also been treated by von Koch's method, but as the soft tissues appear to be absent here, they are of value only as showing the structure of the hard parts. The microscopic structure of the skeleton precisely resembles that of the Lifu specimens described below.

Skeleton. *Microscopic characters.* The fully formed skeleton is built up of a solid mass of polyhedral elements whose surfaces are united together to the complete exclusion of the soft parts. The elements vary considerably in size, 40 μ being a frequent diameter. An exceptionally large one measures 150 μ in its larger diameter. Minute rounded granules are often present at the centre, but the remainder of the element consists of radially disposed crystalline fibres which terminate peripherally in contact with the fibres of adjacent elements (Figs. 3, 4, 8, and 12).

Mineralogical properties. My friend Mr A. Hutchinson, Fellow of Pembroke College, has been so good as to examine a section and also some fragments of the skeleton from the mineralogical point of view, and furnishes me with the following reports on it.

"Under the microscope the section exhibits well-marked spherulitic structure and, when examined between crossed Nicols in parallel light, each spherule is seen to be occupied by a black cross and a system of concentric coloured rings, forming an optic picture similar to that observed when a plate of a uniaxial crystal, cut perpendicularly to the optic axis, is viewed between crossed Nicols in convergent light.

"Examined with a $\frac{1}{4}$ -undulation plate of mica, these optic pictures behave as if they were produced by negative uniaxial crystals.

"The double refraction of the substance is strong.

"The specific gravity, determined by suspending a small fragment of the substance in bromoform, was found to approximate to that of Aragonite. Qualitative chemical analysis showed that the substance is calcium carbonate. Magnesium was tested for with care,

but no certain indication of the presence of that element could be detected in the small portion at my disposal.

"All the properties described above lead to the conclusion that the substance is composed of aragonite."

The Funafuti specimen furnished a larger fragment for analysis and determination of the specific gravity, and of this Mr Hutchinson has made a further examination, with the following confirmatory result:—

"A small fragment was placed in bromoform, and the liquid diluted with benzol till the substance sank. The tube was now connected to an air-pump, and gently warmed until the liquid boiled under diminished pressure; the substance gave off a stream of bubbles, and its density had apparently increased. More bromoform was now added until the substance just remained suspended, and on taking the specific gravity of the liquid it was found to be 2.84 at 15° C.

"Another portion reduced to powder gave similar results.

"The substance is therefore considerably denser than calcite, and as organic matter is present, the specific gravity of the mineral constituent is no doubt greater than that observed.

"The fragment was next dissolved, with the exception of an organic residue, in hydrochloric acid, and tested; it appeared to be pure calcium carbonate, and no trace of magnesium could be detected."

The organic basis of the skeleton, which remains after treatment with acids, varies remarkably in amount. In one specimen (to which the following description applies) it is abundant, while in the two others it is very scanty. At the central regions of the skeletal elements a highly refracting material remains, associated with a deeply staining substance. These are disposed in radiating lines, and often give rise to the appearance of a bright Maltese cross or a star with more than four rays, whose rays of light and dark shift as the focus is altered (Fig. 10, *sk.*). The central region of the skeletal element is often sharply limited by a circular boundary, the limit of the deeply staining substance, and measures from 7—9 μ in diameter. At the peripheral parts of the skeletal elements a less deeply staining and not highly refracting substance remains, which may have a radial arrangement as in Fig. 6, coming in contact at its edge with adjacent elements, and joining with them by a well-marked dividing line. In other cases the peripheral parts of the skeletal elements are represented by a granular matrix, without radial arrangement, and merging, without a boundary line, into the periphery of neighbouring elements (Fig. 10, *sk.*). I am unable to account for the difference between individuals in the amount of the skeletal matrix, or for that between skeletal elements in their structure. It is to be observed that the round central regions of the skeletal elements are of about the same size as the smallest spherules, which are to be found in the jelly. The peripheral region of the element (distinguished by its low refraction and feeble staining power of its matrix) is that which is laid down by concentric additions in the course of growth. In sections of the undecalcified skeleton the two regions are undistinguishable. The organic basis of the skeleton takes a blue stain with picronigrosin, in

which it agrees with that of sponge spicules, and differs from that of Alcyonarian spicules¹.

The scattered linear spicules (*spic.*) represented in Fig. 8 occur both in the soft parts and embedded in the skeleton. I believe them to be of foreign origin.

Origin of the skeletal elements. The gelatinous layer which invests the upper surface is crowded with young growing skeletal elements, the small ones free and spherical, the larger packed together like hailstones, and assuming the polyhedral form (Figs. 5, 7, 8, and 11).

The spherules take their origin in single cells of the jelly, near the upper surface (Fig. 5, *a—d*). In the early stages of growth the nucleated granular cell body is seen as a thin investing layer surrounding the spherule, which is from the first composed of radiately arranged crystalline fibres. The smallest spherules that I have recognised are 7μ in diameter, and I am inclined to think, from this fact and from the appearance of the organic basis described above, that they are of this size when they are first formed. As the spherule increases in size it takes up its position as an element of the fixed skeleton, and in the course of their growth the angular spaces between adjacent skeletal elements are completely filled in, to the exclusion of the soft parts. The elements thus lose their spherical shape and become polyhedral. The external surface of a spherule, in contact with the layer of soft tissue, is often beset with radiating points, and resembles a portion of a spheraster of a siliceous sponge (Fig. 5, *f* and *g*). I find no trace of a skeletogenous *layer* of cells covering the fully formed skeleton; it appears probable that the cells in which the spherules take their origin, remain in relation with them till their growth is finished, but I have only seen them in the early stages.

The arrangement of the skeletal canals. Figures B and C are views of an approximately median section through one of the Lifu specimens. The canal system consists of intimately anastomosing channels, the greater number of which have a direction upwards and slightly outwards, opening on the upper surface and connected with one another by abundant transverse and obliquely running communications.

In Figure A 5 a section of the interior of the Funafuti specimen is seen. Near the centre of the cut surface a group of large canals, having a diameter of from 60 to 80μ , is cut across, whose arrangement corresponds with that of the large pores seen at the surface of this specimen. The canals run close to one another and their general direction is upwards and outwards, diverging from the axis of the fungiform 'original growth.' In addition to those forming the central groups there are others running approximately parallel with them in planes which are set radially to the axis of the group. Moreover, the section lays open at least one canal which is approximately transverse to this axis, and whose course thus corresponds with those radially directed grooves, the initial stages of canals, seen in the Lifu specimen represented in Fig. 1, *a*. In the rest of the cut surface smaller canals are exposed.

It appears probable that the large canals carry the ultimate trunks of the efferent system of the sponge. I have not succeeded in recognising systems of large canals in

¹ For this fact, as well as for his assistance in staining some sections for me with this reagent, I am indebted to Mr G. C. Bourne, Fellow of New College, Oxford.

the sections of the Lifu specimens which I have examined, though the presence of such a system is indicated on the surface of the remaining specimen (Fig. 1, *a*). It may be that a well-marked system of efferent skeletal canals is not developed until the organism attains a certain size, and it seems clear, from the Funafuti specimen, that the systems are multiplied, perhaps by branching of those already existing, as the size is further increased.

In the basal region the canals are less numerous than at the upper surface, a

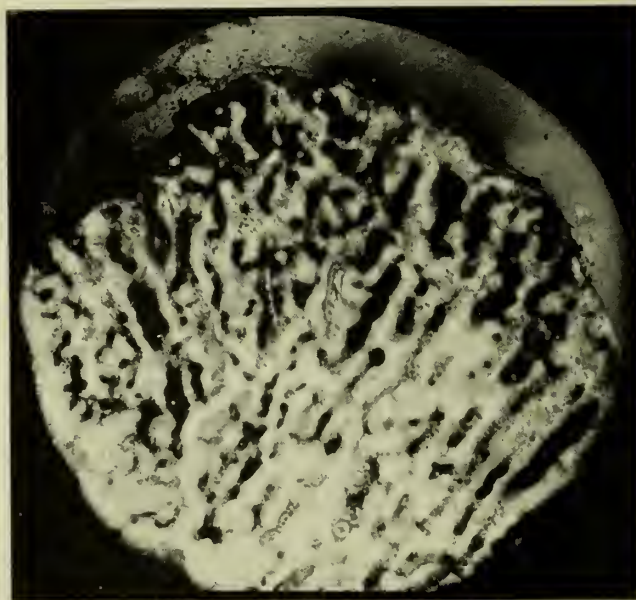


FIG. B. PHOTOGRAPH OF PART OF AN APPROXIMATELY MEDIAN LONGITUDINAL SECTION, BY REFLECTED LIGHT.

The skeleton (white) is seen to be made up of separate elements. The skeletal canals (dark) are occupied by the (stained) soft tissue.

result produced, as sections through this region show, by the closure of the canals by the growth of the skeletal elements which border them (Fig. C, *aa*). The elements increase on the surface turned towards the canal till they come in contact with those of the opposite side. Some canals in the base remain permanently open, and from these the soft tissues are apparently withdrawn towards the growing surface.

It may be well to mention here, what will be evident when the soft tissues are considered, that though the large canals forming the systems above described are probably mainly efferent channels, the remaining skeletal canals, and by far the majority, contain both afferent and efferent trunks of the water-carrying canals of the sponge.

Mode of Growth. Fig. C represents a section through the specimen from which Fig. 2 is drawn, whose axis has curved in the course of growth. The section shows that the layer of growing tissue is not limited to the upper surface, but has, as it were, overflowed for a short distance down that side towards which the growth



FIG. C. AN APPROXIMATELY MEDIAN LONGITUDINAL SECTION THROUGH THE SPECIMEN REPRESENTED IN FIG. 2.

The skeletal canals in the upper part are seen to contain soft tissues, while those at the base are empty. (The canals to the left, marked by oblique shading, contained broken fragments produced by sawing, so that the nature of their contents could not be recognised.) *a, a*. Canals which have been filled in by the growth of the skeletal elements bordering them. *b*. Region of the skeleton formed by overlapping layers of skeletal elements added on the outer surface.

has tended. An examination of the base of this side (*b*) shows that this process has occurred many times in the earlier stages. It appears that the upper (perforated) surface of this specimen has shifted in the course of growth, the canals becoming closed on one side while new ones have appeared on the other. The layer of cortical (unperforated) skeleton which may be seen in the Funafuti specimen (Fig. A, 1) to extend from the bases of the later formed bosses over the surface of the original growth has probably a similar origin.

The specific relationship of the specimens from two localities. As the soft tissues proper to the organism are absent from the Funafuti specimen the question of its specific relationship to those from Lifu may here be considered. Do they belong to the same species, of which those from Lifu represent the younger and that from Funafuti a more advanced stage, or are they specifically distinct? The scanty supply of material prevents a definite answer being given, but the following points may be urged in favour of the former view:

The characters of the skeletal elements are, I believe, identical.

Though the shapes of the organisms from the two localities are very different, there is to be seen in the Lifu specimens a tendency to expand as they grow, which if carried out might well lead to the formation of a structure like that which is called above the original growth of the Funafuti specimen. A similar change of shape occurs in the coral *Fungia*, which in the young state is cylindrical and later expands into a disc.

The differentiation of the efferent (?) canal system appears to be more complete in the Funafuti specimen, but this is a character which might, as above suggested, become more marked in proportion as the extent of the system to be drained increased, and one of the Lifu specimens (Figs. 1 and 1, *a*) shows a distinct indication of it.

The fact that the Lifu specimens (as stated below) contain eggs is an indication that they have attained sexual maturity, but not that they are at the limit of their growth.

It appears that there is at present no sufficient ground for regarding the forms from the two localities as specifically distinct.

The Soft Tissues. The *gelatinous layer* above described as investing the ridges of the skeleton, lines the openings of the canal system and extends as a sheet, thinner in the centre, over the end of each canal (Fig. 8). A round *pore* is frequently present opposite the centre of a canal (Figs. 7 and 11), but in many cases the membrane appears not to be perforated at this point. The spaces at the mouths of the canals are however in communication with one another, by lateral channels through the jelly, beneath the surface membrane.

The soft tissue can be traced for a short distance down the sides as a thin layer, investing the outer surface of the animal.

Besides the cells in which the spherules are formed, there are branched amoeboid cells sparsely scattered through the jelly (Figs. 18 and 19). The jelly, as well as the organic basis of the skeleton, takes a faint blue stain with picronigrosin.

The soft tissues of the interior of the sponge are contained in the skeletal canals and penetrated by the water-bearing canals which open by the pores at the surface. From the main canals small ones are given off which ramify in the layer of soft tissue in contact with the skeleton.

As the canals are followed downwards into the interior, the cellular elements in their walls, at first scattered, become more and more abundant, and the jelly less conspicuous. In some parts of this intermediate region large coarsely granular cells are abundant in the jelly. At a short distance from the surface the soft tissue assumes the characters which are maintained throughout the interior (Fig. 12).

The appearance of a section through it (Figs. 14 and 15—17) suggests that it is largely made up of cells united into a reticulum, with vacuolar spaces of various sizes forming the meshes. The jelly, which is so conspicuous in the surface layers, appears to be scanty or altogether absent here. Besides the smaller, branched protoplasmic masses, with small nuclei ($1.5\text{--}2\mu$ in diameter) which make up the greater part of the reticulum, there are larger and more circumscribed cells with larger nuclei ($2\text{--}3\mu$). Scattered through the reticulum, and with their walls apparently formed by portions of it, are ciliated chambers and the ramifying branches of the canal system.

Ciliated chambers (Figs. 15—17). These are round or oval chambers of minute but fairly uniform size, the larger measuring 18 by 11μ , the smaller 10 by 8μ . (The sections of smaller diameter are doubtless, in many cases, transverse to the long axis of larger chambers.) Their walls appear to be formed by cells which send out processes laterally, and these, joining with one another, bound the chamber; other processes extending away from the chamber are continuous with other cells of the reticulum, while a third set of processes project into the cavity of the chamber, and each, tapering gradually from its base, forms a flagellum which may extend across to the other side of the chamber. There is no indication of a collar or of the abrupt truncated termination of the cell-body at the base of the flagellum, which are usually seen in choanocytes. A well-marked nucleus is situated at the base of the flagellar process, at its junction with the body of the cell. The flagella project from about half the inner surface of the chamber, some four or five commonly appearing in section, and their tips thus converge and are often seen to have become entangled. The remainder of the inner wall of the chamber is smooth and at some point in it the cavity opens into a branch of the canal system by a narrow passage, about 4μ in diameter (Fig. 17). This is only rarely seen as a distinct passage, owing to its narrow lumen.

Considering how readily the collar cells of sponges lose their characters unless special measures are taken to preserve them, it cannot be assumed that the condition above described of the cells lining the ciliated chambers is precisely that of the living state. It is perhaps possible that they had in life the usual characters of collar cells, but if so, it is curious that while the flagella are preserved they should have lost not only their collars, but also the truncated shape of the ends turned towards the centre of the chamber. And, in view of the unique character of the skeleton of *Astrosclera* it is quite possible that the cells of its ciliated chambers were also of a peculiar type. We cannot, with the present material, arrive at certainty on the point.

All I can say is that in the material, preserved as it has been, the condition appears to be as I have described.

Canal System. The large trunks of the canal system and the small branches which ramify in the layer of tissue containing ciliated chambers have nuclei scattered uniformly in their walls (Fig. 12, canal to right, and Fig. 14, *c*), but I have not succeeded in recognising cell limits about them.

Most of the skeletal canals are lined by tissue containing ciliated chambers in abundance, though in some rare instances, as in the left-hand canal represented in Fig. 12, the lining contains no ciliated chambers. It may be that these are efferent passages, but I have not succeeded in recognising in the Lifu specimens, (which alone contain the soft tissues,) a clearly differentiated system of large canals corresponding to those seen in the Funafuti specimen.

The existence of ciliated chambers implies the presence of systems of afferent and efferent canals; and as a matter of fact we find that the tissue containing the ciliated chambers is traversed by trunks which give off small branches into the tissue. Of the small branches seen in the tissue some may well be tributaries of the efferent system of canals.

It appears that in this young stage at least, the main trunks of the efferent system are in many cases also surrounded by tissue containing ciliated chambers, together with efferent tributaries and the ultimate branches of the afferent system, so that in sections of the soft parts the two systems of canals are not recognisable by their anatomical characters.

Reproduction. Each of the three specimens examined contained large eggs or embryos (Figs. 8, 9 and 10). They are found, solitary or two together, near the orifice of one of the larger canals, separated from the skeletal wall by a thin layer of soft tissue. I have not been able to recognise eggs in a young stage. An advanced *ovum* in one specimen (Fig. 9) measures 0.1 mm. in length, and has a thick-walled nucleus 25μ in diameter, and a well-marked germinal spot. An *embryo* in the same specimen (Fig. 10) is rather larger than the egg. At the surface there is a superficial layer of nuclei, and the protoplasm about them is disposed in columns perpendicular to it. Internally the columns are merged in the granular protoplasm, which occupies the interior of the embryo, obscurely divided up into irregular masses, but I have not succeeded in detecting nuclei in them. None of the embryos have a segmentation cavity. It appears that the development leads to the formation of a larva of a *parenchymula* type, rather than an *amphiblastula*.

I have not been able to recognise any stage in the formation of spermatozoa.

State of Preservation. The three specimens whose soft parts have been examined do not show the structure equally well. The above description is given from the Lifu specimen which was prepared by von Koch's method, and of which part was cut into sections 5μ in thickness. In another specimen the reticular character of the soft tissue is clearly seen, but the flagella of the ciliated chambers are obscure. This is partly due to the fact that the sections are in this case considerably

thicker than the diameter of the ciliated chambers, so that the latter cannot be seen actually in section. There is however another fact about this specimen which may possibly explain the obscurity in the structure of its tissues. The canal system contains in many parts hosts of minute deeply staining rod-like bodies ($1-5\mu$ in length), looking very like bacteria (Fig. 20, *b.*). They occur in scattered groups or apparently embedded in some clear homogeneous substance, in such masses, that they appear to distend the canals. Three possibilities as to their nature have occurred to me, namely, that they are bacteria, spermatozoa, or the remains of food. They are not symbiotic bacteria, for they are absent from the two other specimens. The crisp, evidently growing surface of this specimen, and the excellent preservation of the eggs and embryos (those represented in Figs. 9 and 10 were contained in this specimen), seems to put the view that the animal was undergoing decay, out of the question. I do not think that the bodies are spermatozoa, for I have found no trace of sperm morulae or any of the earlier stages of development of spermatozoa. If they are the remains of food it is remarkable that they should be found only in one specimen, and I am moreover entirely at a loss to form a conjecture as to the nature of the food which would leave such remains.

AFFINITIES.

That the animal under consideration belongs to the *Porifera* seems clear from the presence in the soft tissues of chambers provided with flagella and communicating with a system of canals which ultimately open to the exterior by pores. The soft tissues are moreover supported by a skeleton composed of elements secreted by cells scattered through the jelly.

On the other hand that it is not a Coelenterate is shown by the absence of polyps, mesenteries and thread-cells.

There is at first sight some resemblance between a section of the skeleton of *Astrosclera* and sections in certain planes of the skeleton of the *Madreporarian Corals*. In these the fibres of the skeleton are disposed in fascicles and diverge from one another about an axis which occupies the centre of the fascicle. A section which cuts the fascicles transversely thus presents the appearance of fibres radially disposed about a number of centres. Such a section is shown in Fig. 10 and other figures of Miss Ogilvie's memoir "On the Microscopic and Systematic Study of the Madreporarian Types of Corals¹." But, as Miss Ogilvie clearly shows, these systems of radiating fibres are made up of lamellae successively deposited on the surface of the skeleton, so that any particular fibre of a fascicle traverses many lamellae in its course. We know from the work of von Koch, von Heider and others that the skeleton is formed by a layer of cells, the calyco blasts, in contact with its surface. It will be readily seen that the resemblance between these radiating systems of fibres, and those formed within single cells of *Astrosclera*, can only be superficial.

¹ *Philosophical Transactions*, vol. 187, B (1896).

In von Koch's account of the development of the skeleton in *Asteroides calycularis*¹ its elements at their first appearance are described as spheroidal bodies, which become polyhedral by apposition and possess a radiate structure (Pl. 20, Fig. 7). They have the appearance of being partially divided into two pieces. Von Koch regarded these bodies, as well as the later formed skeleton, as excretions, formed by the calycoblast (epiblast) cells of the coral.

The precise relation of the calycoblasts of corals to the skeleton which they form is however still uncertain. The question is whether the skeleton is, as von Koch and other authors have supposed, secreted by the layer of cells in contact with it, or built up of cells of this layer which themselves become calcified. Miss Ogilvie urges strong reasons in favour of the latter view.

In either case it is not clear what the relation of the spherules described by von Koch to the fully-formed skeleton may be, for in this such spheroidal elements do not appear to be present.

I mention these spherules here because they are skeletal elements which correspond in composition (aragonite), and to more extent in structure, with those of *Astrosclera*, but not as evidence of any close affinity of the latter with the Coelenterates.

But, admitting that *Astrosclera* is a sponge, there are many features which separate it from the living members of this group. Among these may be mentioned:—

(a) The shape of the skeletal elements. They are polyhedra which begin in a spherical and may pass through a spheraster stage.

(b) Their union to form a rigid skeleton, excluding the soft parts. In *Petrostroma* Döderlein, the representative of the *Lithonina*², the supporting skeleton is formed of fused spicules, but these are modified quadriradiates. We are at present without information on the soft tissues of this form.

(c) The mode of growth, by the addition of new skeletal elements at the upper surface, and without interstitial growth. In this feature also it probably agrees with *Petrostroma*.

(d) The limitation of the pores to the upper surface.

Tentorium (Vosmaer), a siliceous sponge classed with the *Polymastidae*, presents a similar limitation.

(e) The absence of a central atrial space.

(f) The small size (18 by 11 μ) of the ciliated chambers. The smallest size given by Haeckel for the ciliated chambers of the *Leucones* (in which group they are smaller than those of other *Calcarea*) is 60 by 40 μ . Among the *Non-calcarea*, 42 μ is the smallest diameter that I have found given for the ciliated chambers.

¹ "Ueber d. Entwicklung d. Kalkskeletes von *Asteroides calycularis* u. dessen morphologische Bedeutung." *Mitth. aus d. Zool. Stat. zu Neapel*, Vol. 3, 1882, p. 284.

² Döderlein, L., "Ueber die Lithonina, eine neue Gruppe von Kalkschwämmen." *Zool. Jahrbücher, Syst. Abth. x.* (1898), p. 15.

(g) To these points of difference is perhaps to be added the character of the flagellated cells lining the ciliated chambers. They appear, though the point needs confirmation from specially preserved specimens, not to be collar cells of the ordinary type, but more or less amoeboid and without a collar, and with one of their processes gradually tapering into the flagellum.

From the *Calcareum Astrosclera* also differs in the following features:—

(a) The flagellate cells are limited to about half the interior of the ciliated chambers.

(b) There appears to be a long and complex canal system both on the afferent and efferent sides of the ciliated chambers.

(c) The mineral constituent of the skeleton is *aragonite*, not *calcite*.

Comparison of ASTROSCLERA with the PHARETRONES.

The *Pharetrones* are calcareous sponges which are found in beds ranging from the Carboniferous to the Cretaceous formations. In the arrangement of their skeleton they differ widely from living sponges except *Petrostroma* the type of the *Lithonina*. Dr Hinde has recently described¹ some sponges from the Eocene beds of Australia which appear to be intermediate forms connecting the *Lithonina* and the *Pharetrones*.

The resemblance in general characters between *Astrosclera* and some of the *Pharetrones* appears to me so striking as to deserve consideration, although I have to conclude that the differences in the minute structure of the skeleton forbid their being considered as really allied.

The feature characteristic of many members of this group (though authorities are by no means agreed on its essential characters or limits) is that the spicules are united in close apposition to form trabeculae or 'fibres,' as they are technically called. Dr G. J. Hinde writes, "in no existing sponge is there the same disposition of the spicules of the interior to form anastomosing solid fibres as in this and other allied fossil forms; and this character forms the distinctive feature of the *Pharetrones*, sharply marking them off from the families of existing Calcisponges."²

The centre of the sponge is often occupied by a space, the gastral cavity, with a wide opening above, and penetrating more or less deeply into the interior. The system of anastomosing canals which lies between the trabeculae of the skeleton communicates on the one hand by fine pores with the exterior, and on the other, either by irregularly anastomosing channels or by definite tributary trunks, with the gastral cavity. In some cases the gastral cavity may be so shallow as almost or altogether to cease to exist, and in that case a group of large tributary trunks opens directly to the exterior or at the bottom of a shallow depression. A cortical layer, which has been thought to be imperforate, often clothes the sides of those members of the group which are pedicellate or cylindrical, and if this is so the pores opening to the

¹ G. J. Hinde, "Calcisponges from the Eocene of Victoria (Australia)." *Quart. Journ. Geol. Soc.*, Vol. LVI. 1900, p. 50.

² "Notes on Fossil Calcispongiae," *Ann. and Mag. of Nat. Hist.* Ser. 5, Vol. x. (1882), p. 196. This was written before the discovery of the *Lithonina*.

exterior are limited to the upper part of the sponge. In some cases radiating grooves are present on the upper surface, converging towards the mouth of the gastral cavity, or towards the group of large pores which represents it, the initial stage of radiating tributary canals of the interior.

In the genus *Stellispongia* the gastral cavity may, as above noted, be absent altogether, and a single group of large pores and radiating grooves may occupy the centre of the upper surface of the sponge. In other cases, and even as it appears within the limits of the same species, the number of these groups of pores may be multiplied.

Among a number of specimens of *Stellispongia variabilis* which I obtained from Triassic deposits in the neighbourhood of St Cassian, in the Tyrol, and which have been kindly named for me by Dr Hinde, there are specimens, referred to the variety *c* of that species, expanding rapidly from a short pedicellate base, clothed on the outer surface with a wrinkled cortical layer, and presenting in the middle of the upper surface a shallow depression whose sides are marked by radiating grooves, the first stage, as we have seen of the tributary canals of the interior. In another example of the species the rounded upper surface presents numbers of these systems of large pores and radiating grooves, in some cases in depressions, in others flush with the general surface.

The resemblances between the surface of the latter specimen and that of the bosses of the Funafuti specimen of *Astrosclera*, and between the general habit of growth of the former specimen and the earlier formed part of the Funafuti specimen are certainly very remarkable.

On turning our attention, however, to the elements of which the skeleton is composed we find a marked difference. In those *Pharetrones* in which their characters have been determined they are tri-radiate or quadri-radiate spicules, often having the rays bent or reduced to allow of their being packed together to form the solid trabeculae, but still distinctly referable to these types. They are well seen in the Warminster specimens described and figured by Dr Hinde¹, who succeeded in obtaining isolated spicules. The characters of the skeletal elements are however often found to have been obliterated to a greater or less extent in the process of fossilization and all traces even of the existence of spicules may be lost.

In sections of the specimens of *Stellispongia* above mentioned the skeleton is seen to be composed of bodies round in transverse section, but elongated in longitudinal with a length often eight times the breadth, and with no definite structure discernible in their interior. The appearance agrees with that figured by Steinmann for this genus². The outlines of the elements which make up the trabeculae are blurred, owing apparently to commencing recrystallization, so that it is not easy to decide on their original shape. Rauff³ asserts that tri-radiate spicules are to be recognised in some specimens of *Stellispongia* from the Trias, and in my sections the elements often present

¹ "Notes on Fossil Calcispongiae," *loc. cit.*

² Cp. Steinmann's figure, "Pharetronen-Studien," *Neues Jahrbuch f. Mineralogie, &c.* 1882, Bd. 2, Pl. ix. Figure 2.

³ *Palaeospongiologie*, Th. 1. *Palaeontographica*, Vol. xl. p. 99.

an angular bend in their course, which is quite consistent with this statement. It is probable then that the skeleton of *Stellispongia* is of the same spicular type as that of other *Pharetrones*.

It cannot, therefore, be claimed that there is any resemblance between these spicules and the polyhedral elements of *Astrosclera*.

We are confronted then with the facts (1) that there have existed a group of sponges, the *Pharetrones*, with the above-mentioned characteristic features of their anatomy and a skeleton composed of spicular elements, and (2) that *Astrosclera* exists at the present day approaching some members of the *Pharetrones* closely in the general features of its anatomy, but with a skeleton of polyhedral elements.

Now the characters of the elements of the skeleton are those which are mainly relied on in the classification of sponges, whether of the large groups, as the names *Hexactinellida*, *Tetractinellida*, *Monaxonida* imply, or their subdivisions.

As regards *form*, the difference between the skeletal elements of *Astrosclera*, whether in their early spherical or spheraster-like state, or in their later shape of polyhedra, and the tri- or quadri-radiate spicules of the *Pharetrones* is as great as can be found among the spicules of sponges.

As regards *development*, the best clue we have to the way in which the spicules of the *Pharetrones* were formed is furnished by Minchin's observations on the growth of tri-radiate and quadri-radiate spicules in Calcareous sponges at the present day. Minchin finds, and I have myself had the opportunity of examining his beautiful preparations, that a tri-radiate spicule is laid down by a group of six cells, derived originally from three, each of which give rise by division to a pair which preside over the formation of one ray of the spicule. In *Astrosclera*, as we have seen, the spherules of the skeleton are contained at their first appearance in a single cell.

Finally, as regards *composition*, the carbonate of lime is in *Astrosclera* in the form of aragonite, while, from the analogy of the spicules of the *Calcarea* of the present day, we may suppose that those of the *Pharetrones* were of calcite.

To judge then by the rules which have become established in classifying sponges, we must conclude that *Astrosclera* is a representative of a distinct family, and not closely allied to the *Pharetrones*. The resemblances between the two groups may on this view be ascribed to the similarity of the conditions under which they have grown. On the whole, I believe that this is the correct conclusion, though the resemblances are so striking that I can hardly persuade myself to admit that they can be only adaptive.

To fortify myself in this conclusion I have to reflect on such cases of similarity in general habit between widely separated groups as that shown by some members of the *Euphorbiaceae* and the *Cactaceae*, orders which no botanist would admit to be allied to one another.

Apart from the nature of the elements constituting the trabeculae I do not know what characters could be given to distinguish *Astrosclera* from some of the *Pharetrones* such as *Stellispongia*, and it appears very possible that among the forms included in this group whose microscopic characters have not been ascertained, there may be some with polyhedral skeletal elements, truly allied to it.

On the Spherulitic Structure seen in Pharetrones from St Cassian and elsewhere.

In the triassic deposits of St Cassian and others occurring near Schludersbach and referred to the same horizon, representatives of the *Pharetrones* occur in which the carbonate of lime trabeculae of the skeleton show no trace of spicules, but, instead, they are made up of more or less polyhedral systems of radiating lines which at their periphery are in contact with adjacent systems either by a sharp or a confused boundary¹. They thus remarkably resemble the trabeculae of the skeleton of *Astrosclera*.

The view of this structure held by Zittel, and by most palaeontologists who have considered the matter, is that it is secondary, being due to a recrystallization of the lime. I have carefully examined sections of specimens which I obtained from these localities, in several of which the sphaerulitic structure is well marked, and I am prepared to accept this conclusion as correct.

The evidence bearing on the matter may be arranged under separate heads.

a. If the spherulitic structure of the fossils were primary we might expect that those in which it is present would form a group differing in other respects from the *Pharetrones* with a spicular skeleton. The opposite is the case.

Among the genera included in the group there are simple forms, of which *Stellispongia* and *Corynella* may stand as examples, and remarkable segmented forms consisting of hollow segments superposed one upon another, so that the roof of one forms the floor of its successor. These have been divided by Steinmann as a separate group, the *Sphinctozoa*, and Zittel regards them as so distinct that he removes them from the *Pharetrones*, and classes them in a separate order. The precise relationship of the two groups does not materially affect our present enquiry.

The genus *Verticillites* is one of these segmented forms. In a representative of it occurring in the Greensand beds of Warminster (*V. D'Orbigny*, Hinde) the composition of its walls of tri- and quadri-radiate spicules has been demonstrated as clearly as in any recent sponge. (Cp. Hinde, *Ann. and Mag. N. H.* 5, x. Pl. x. Fig. 3 &c.)

On the other hand, the genera *Thaumastocoelia* and *Enoplocoelia* of Steinmann are examples of the segmented forms from the triassic strata of St Cassian, and the specimens which have been examined present, wholly or in part, a spherulitic structure of the walls. (The structure was regarded by Steinmann as primary in the former genus, but as secondary in the latter.)

Again, the genus *Corynella* is one of the unsegmented forms and possesses distinct characters².

¹ The structure is figured by Zittel, "Studien über fossile Spongien, III.," *Abh. d. Math.-Phys. Classe d. kön. bayerischen Akad. d. Wissenschaften*, Bd. XIII. Abth. 2, Pl. XII. Fig. 5 (*Corynella gracilis*), also in his *Grundzüge der Palaeontologie*, p. 59, Fig. 88.

² According to Zittel's description ("Studien über fossile Spongien," p. 35) they are usually solitary sponges, cylindrical or pear-shaped, thick-walled, and with a truncated or rounded upper surface. The gastral cavity is funnel-shaped, rarely reaching to the base. Radial grooves are often present round its mouth and wide tributary tubes pass outwards and downwards from the gastral cavity. As they penetrate the walls they become narrower and ultimately open by fine inhalent ostia at the surface. A thick dermal layer is sometimes present at the base. The skeletal fibres are coarse, chiefly composed of simple spicules, but with some large tri-radiate ones.

With regard to the 'simple' spicules Hinde points out that those of *C. socialis* are tri-radiates so modified that they might very readily be mistaken for simple ones.

In *C. rugosa*, from the Upper Greensand of Warminster, Hinde succeeded in obtaining complete and isolated tri-radiate spicules (*loc. cit.*, Pl. XI. Fig. 25), and sections of well-preserved specimens of this genus commonly show the 'fibre' to be composed of such spicules.

In Zittel's figure of a specimen of *C. gracilis*, Münstr. from St Cassian, alluded to above, no trace of spicules is to be seen, and the 'fibre' has instead a well-marked spherulitic structure.

Now on the view of the primary nature of the bodies with radiating lines, making up the spherulitic structure, we are driven to suppose that among the sponges which have been regarded as *Pharetrones* there are two groups, one with spicular skeletal elements, the other with polyhedral skeletal elements and that both have developed into simple and segmented forms. It was shown in the last section that in its larger characters *Astrosclera* does remarkably resemble such unsegmented forms of the *Pharetrones* as *Stellispongia*. But that there should also be segmented forms with polyhedral skeletal elements resembling the segmented *Pharetrones* would indeed be an astonishing instance of parallel development.

b. Many intermediate conditions are met with between a 'fibre' composed of spicular elements and one exhibiting the spherulitic structure. Thus the fossils belonging to the genus *Corynella* have, as we have seen, in many cases, a fibre composed of spicules. In a section of a specimen of *C. foraminosa* from the Lower Greensand of Faringdon¹, while the spicular elements are clearly seen in the centres of the fibres, their peripheral parts present a fine crystalline striation perpendicular to the surface, and there is no sign of spicules in these regions.

Again, though the spherulitic structure is so clearly marked in the specimen of *Corynella gracilis* Münstr. above alluded to, in one of my specimens (from Schluderbach) referred by Dr Hinde to this species, the central parts of the trabeculae are made up of elongated bodies which may well be the remains of spicules, though here too there is at their periphery a crystalline striation more or less perpendicular to the surface, though the lines are in part disposed in groups with a fan-like radiating arrangement.

Similarly, in *Pharetropongia Strahani* Sollas, the 'fibre' is often seen to contain spicules lying, as in a quiver, in a direction parallel to the surface, but in one of Dr Hinde's sections of a specimen of this species, no trace of spicules is to be seen, and instead, the 'fibre' presents lines sometimes disposed perpendicularly to the surface, sometimes extending in fan-like and frond-like systems, with definite boundaries between them, recalling the patterns on a window-pane in frosty weather.

If the spherulites with fibres radiating in all directions are regarded as primary elements of the skeleton, what, it may be asked, is to be made of the imperfect systems, and of these borders of fibres set nearly perpendicularly to the surface of the trabeculae, which are of much more frequent occurrence?

c. Although, in its more marked form the spherulitic structure does remarkably resemble that seen in *Astrosclera* there is, I believe, this difference; that whereas the radiating lines in the latter run straight from the centre to the circumference of

¹ Kindly lent to me by Dr Hinde.

the skeletal elements, in the former the diverging lines are frequently grouped in frond-like systems, whose axes radiate from the common centre.

d. Even in the same specimen the spherulitic structure may be found in one part of a specimen and the spicular structure in another. Thus Zittel speaking of the spherulitic structure, says:—"Auch dieser Erhaltungszustand kommt zuweilen an Exemplaren vor, bei denen sich einzelne Fasern noch deutlich als aus Nadeln bestehend erweisen." (*Studien über fossile Spongien*, III. p. 14.)

e. In a specimen of *Corynella tetragona* figured by Zittel (Pl. XII. Fig. 2) the trabeculae are composed of apparently simple spicules embedded in a matrix, but the spherulitic structure is also present, printed as it were over the other, and with its radiating fibres pursuing their course regardless of the presence of the spicules.

f. In some of my St Cassian specimens the spherulitic structure is limited to the trabeculae, but in many cases it extends out from them into the calcite mosaic which fills in the original spaces of the sponge, and in some cases spherulites occur distinct altogether from the trabeculae and isolated in the calcite filling the spaces.

There is one argument which has been brought forward in favour of the primary nature of the systems making up the spherulitic structure, which deserves further consideration. Steinmann describes in the wall of *Thaumastoecolia* which has this structure, minute ramifying passages which he believes to be Thallopiphyte borings, and appeals to their presence in support of the view that the parts which they penetrate had their present structure at the time that the borings were made¹. If this conclusion were justified, I do not see how the argument could be met. Rauff² doubts the interpretation which Steinmann gives of these markings, and expresses his belief that they indicate the remains of spicules. What their real nature may be in this particular case I am, of course, unable to say, but in one of my own specimens of a Pharetronid from Schludersbach, the spherulitic structure is very clearly marked, and the systems of radiating lines are traversed by ramifying markings resembling those figured by Steinmann, and certainly not the remains of spicules. They precisely resemble the borings which are found in shells and corals at the present day, made by an organism sometimes referred to the genus *Achlya*³. The conclusion, however, that the presence of these borings is evidence that the skeleton which they penetrate has retained the same structure that it had when the borings were made seems to me to be quite uncertain.

On the view that the spherulitic structure is the result of the recrystallization of the lime, replacing the original spicular structure, it is not to be supposed that the systems of crystalline fibres have mechanically pushed their way from the centres through the trabeculae of the skeleton to the destruction of any delicate bodies that

¹ Steinmann G. "Pharetronen-Studien." *Neues Jahrbuch für Mineralogie*, &c. Jahrg. 1882, Bd. II. p. 139. The passage alluded to is on p. 186, "Es liegt auf der Hand..."

² *Palaeospongiologie* (*Palaeontographica*, Bd. XL.), p. 100.

³ *Achlya* is one of the *Saprolegnieae*. The grounds for this view of the relationship of the organism seem insecure.

might be present, but that they result from slow molecular changes set up in the trabeculae in continuity with the parts already changed.

The whole question of the cause of the change and the way in which it has operated is, of course, very obscure, but I have had the opportunity of seeing what appears to be an instance of a somewhat similar process in a specimen of fossil wood in the possession of my friend Mr Seward, and figured by him in his work on *Fossil Plants* (Fig. 14, B, p. 81). The siliceous matrix of the specimen has at certain points taken on a definite structure, showing concentric alternating rings of light and dark. In longitudinal sections the structure of the woody fibre is obscurely seen in the regions outside the systems of concentric lines, but within them, precisely where the change in the matrix has occurred, the structure is preserved in exquisite perfection, so that the minute transverse striations on the walls of the vessels are clearly seen.

There seems therefore to be good reason for believing that in the case of the St Cassian sponges the spherulitic structure is the result of recrystallization and masks a primary spicular structure. The possibility must however be borne in mind of the occurrence of *Astrosclera* or allied forms in a fossil state. If the fossils retained their original structure they would differ from the St Cassian sponges which I have seen, in the absence of traces of a spicular skeleton, and also, I believe, in the strictly radial character of the fibres composing their skeletal elements, and in the uniformity and completeness of the radiating systems thus formed.

From one point of view the resemblance between the radiate structure of the skeletal elements of *Astrosclera*, and that of the spherulitic systems of the fossils is interesting; namely that it is an instance of the formation in living protoplasm of a skeletal structure composed of carbonate of lime in a form almost identical with that which this mineral may take in crystallizing outside a living body, and thus in inorganic surroundings.

THE FAMILY ASTROSCLERIDAE.

In view of the isolated position which *Astrosclera* holds among sponges it must be regarded as the type of at least a separate family. It appears indeed that a larger division will have to be established for its reception, but until specimens are available in which the minute characters of the soft parts can be determined with certainty, the establishment of such a division may be deferred.

I propose to call the new Family *Astroscleridae*. Its characters are, at present, those of the species which constitutes it, namely:

Sponges which are nearly cylindrical, or expand from a narrow base into a wide disc,—differences in shape which may represent stages of growth. The upper surface is convex.

The sides and the under surface of the disc, when this is present, are imperforate and more or less conspicuously marked by annular wrinkles.

The upper surface is pitted by closely set pores, the openings of the skeletal canal system. The pores may be irregularly distributed, or larger pores may be arranged in one or more systems of radiating lines.

The skeleton is rigid and built up of elements consisting of aragonite, contained in an organic basis, and having a fibrous structure disposed in lines radiating from a point in the centre of the element. The elements are formed in single cells and are at first free and spherical, they may pass through a spheraster stage, and are ultimately built together, becoming polyhedral by mutual apposition into a compact skeleton from which the soft tissues are excluded.

The skeletal canals permeate the skeleton freely branching and anastomosing, and open at the pores on the surface. In the later stages (?) of growth, large trunks of the skeletal canal system are formed, which open at the larger pores at the surface.

The soft tissues form a layer at the surface, and are contained in the skeletal canals. The ciliated chambers are minute (18 by 11 μ) and both afferent and efferent systems of canals are long and branched. It is probable that the larger efferent trunks run in the large skeletal canals. There is no common atrial cavity, and the canals communicate with the exterior by pores in the gelatinous layer covering the upper surface.

The larva belongs to the *parenchymula* type.

Astrosclera willeyana occurs at depths of 35 to 40 fathoms at Sandal Bay, Lifu, Loyalty Islands, and at a depth of 100 fathoms on the outer slope of Funafuti, Ellice Islands.

The name of the genus *Astrosclera* is descriptive of the star-like arrangement of the fibres in the skeletal elements, and I propose the specific name *willeyana* in commemoration of Dr Willey's labours among the islands of the Western Pacific, carried on with persistence and enthusiasm and more than once at no small personal risk, in pursuit of the object which he had in view.

In conclusion, I wish to express my thanks to the authorities of the British Museum for allowing me to examine the Funafuti specimen of *Astrosclera*; to Dr G. J. Hinde, F.R.S. for naming my *Pharetrones* from the Tyrol, and for his kind assistance in other ways; and to Mr Hutchinson of Pembroke College, for his careful determination of the physical and chemical properties of the specimens of the skeleton of *Astrosclera* which I placed in his hands.

DESCRIPTION OF PLATES XLV—XLVIII.

(Lister. Astrosclera.)

REFERENCES.

- c.* canal. *c'*. small canal.
- c. ch.* ciliated chamber.
- c. j.* scattered cells of the jelly.
- cort.* cortical layer of the skeleton.
- l. c.* large cells of the soft tissue.
- m.* surface membrane.
- p.* pore.
- sk.* skeleton.
- sk. e.* skeletal element.
- sph.* spherule, young stage of skeletal element.
- spic.* spicule (of foreign origin).

All the Figures which follow are drawn from specimens from Lifu.

PLATE XLV.

FIG. 1. Side view of a specimen 8 mm. in height.

FIG. 1*a*. View of the upper surface of the same specimen.

FIG. 2. Side view of a specimen which has curved in the course of growth, so that its axis comes to be parallel with the surface of attachment. Height 10.5 mm.

FIG. 2*a*. View of the upper surface of the same specimen.

FIG. 3. Part of a chip broken from the skeleton. $\times 570$.

FIG. 4. Four skeletal elements, from a thin section. $\times 690$.

FIG. 5. Skeletal elements from the upper surface in different stages of growth. $\times 690$.

a. One of the skeletogenous cells of the jelly, containing a small spherule 8μ in diameter. Other cells of the jelly are also seen.

b—d. Growing spherules, invested by the skeletogenous cells. *n.* Nuclei of the latter.

e. A growing spherule still free in the jelly.

f. Spherules becoming adherent and with flattened adjacent surfaces.

g. A skeletal element in the *spheraster* stage.

FIG. 6. Section of the organic basis of the skeleton of a decalcified specimen. $\times 570$. At *b* a skeletal element with an unusually large centre is shown.

FIG. 7. Two of the depressions in the upper surface (represented in Figs. 1*a* and 2*a*) seen from above and illuminated by direct sunlight. *b.* is seen obliquely. The surface membrane is shown perforated by pores (*p.*) and containing spherules.

PLATE XLVI.

FIG. 8. Part of a vertical section. $\times 105$. The skeleton, formed of polyhedral elements, is coloured grey, and the soft tissue pink. The gelatinous layer of the upper surface is seen to contain scattered cells (*c. j.*) and spherules. It forms a thin membrane (*m.*), imperforate in the portion seen in this section, over the spaces connected with the openings of the canals. The beginning of the deeper-lying tissue with ciliated chambers (*c. ch.*) is seen at the lower part of the figure. To the right an *embryo* is seen lying near the mouth of a canal.

FIG. 9. Section of an unsegmented egg showing the large nucleus (*n.*) and nucleolus. \times about 300.

FIG. 10. Section of a segmented embryo. The stained centres of the skeletal elements are seen in the tracts of decalcified skeleton about it. \times about 300.

PLATE XLVII.

FIG. 11. Part of a vertical section showing a pore (*p.*) in the surface membrane. $\times 105$.

FIG. 12. Part of a vertical section through the interior, cutting two of the large canals (*c.*) longitudinally. $\times 105$. Small canals given off from the large ones are seen to penetrate and divide in the tissues throughout which the ciliated chambers (*c. ch.*) are scattered.

FIG. 13. Part of a thick transverse section, showing the network of skeletal canals in the interior, and the unperforated cortical layer (*cort.*) of the skeleton.

PLATE XLVIII.

FIG. 14. Part of a thin transverse section through the soft tissue of the interior, from a decalcified specimen. The skeleton has been filled in in a diagrammatic manner. $\times 170$.

FIG. 15. Part of a thin transverse section through the soft tissue of the interior. $\times 980$. The ciliated chambers are seen, with the flagellar processes projecting into them. Some larger cells (*l. c.*) are scattered through the protoplasmic reticulum.

FIG. 16 *a* and *b*. Two ciliated chambers. $\times 980$. In *b* a small canal is seen to be in close proximity to the chamber.

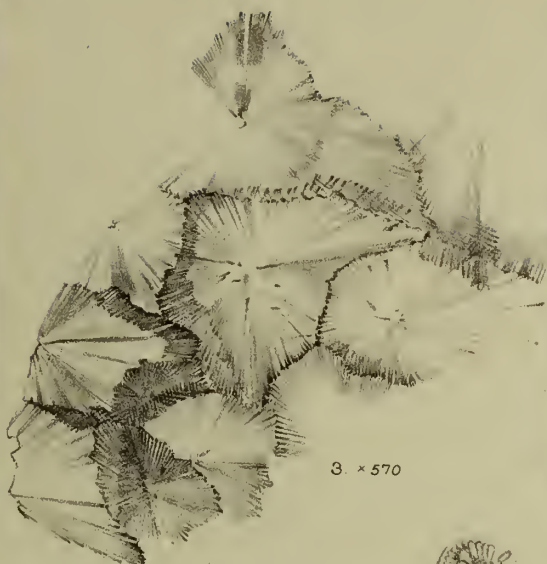
FIG. 17. Section showing communication between a ciliated chamber (*c. ch.*) and a small canal (*c'*).

FIGS. 18 and 19. Groups of scattered cells in the jelly near the upper surface.

FIG. 20. Section through the soft tissue of a specimen whose canal system contains masses of rod-shaped bodies (*b.*). $\times 250$.



1



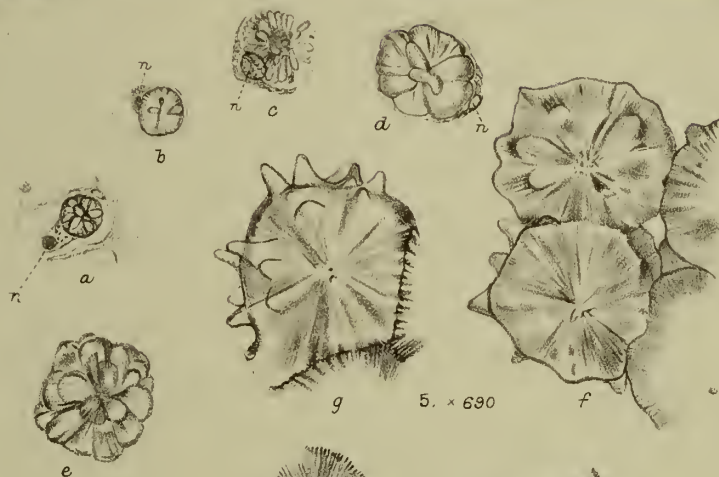
3. x 570



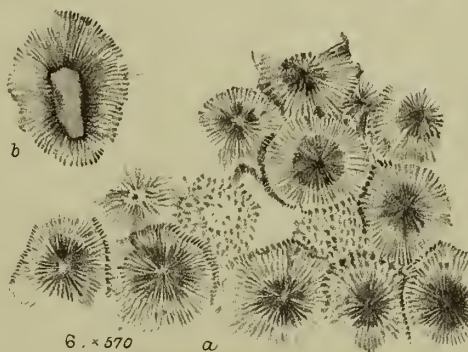
1a.



4. x 690



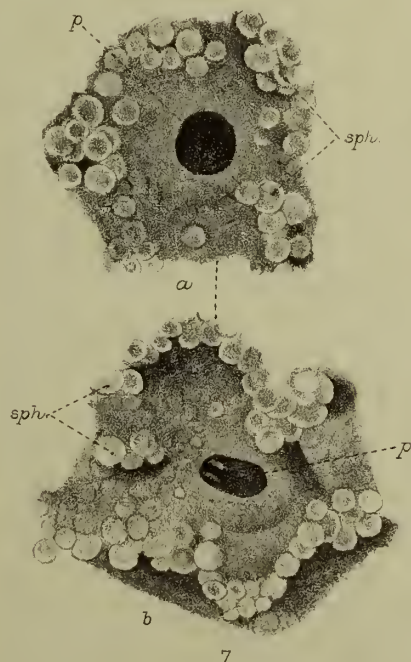
5. x 690



6. x 570



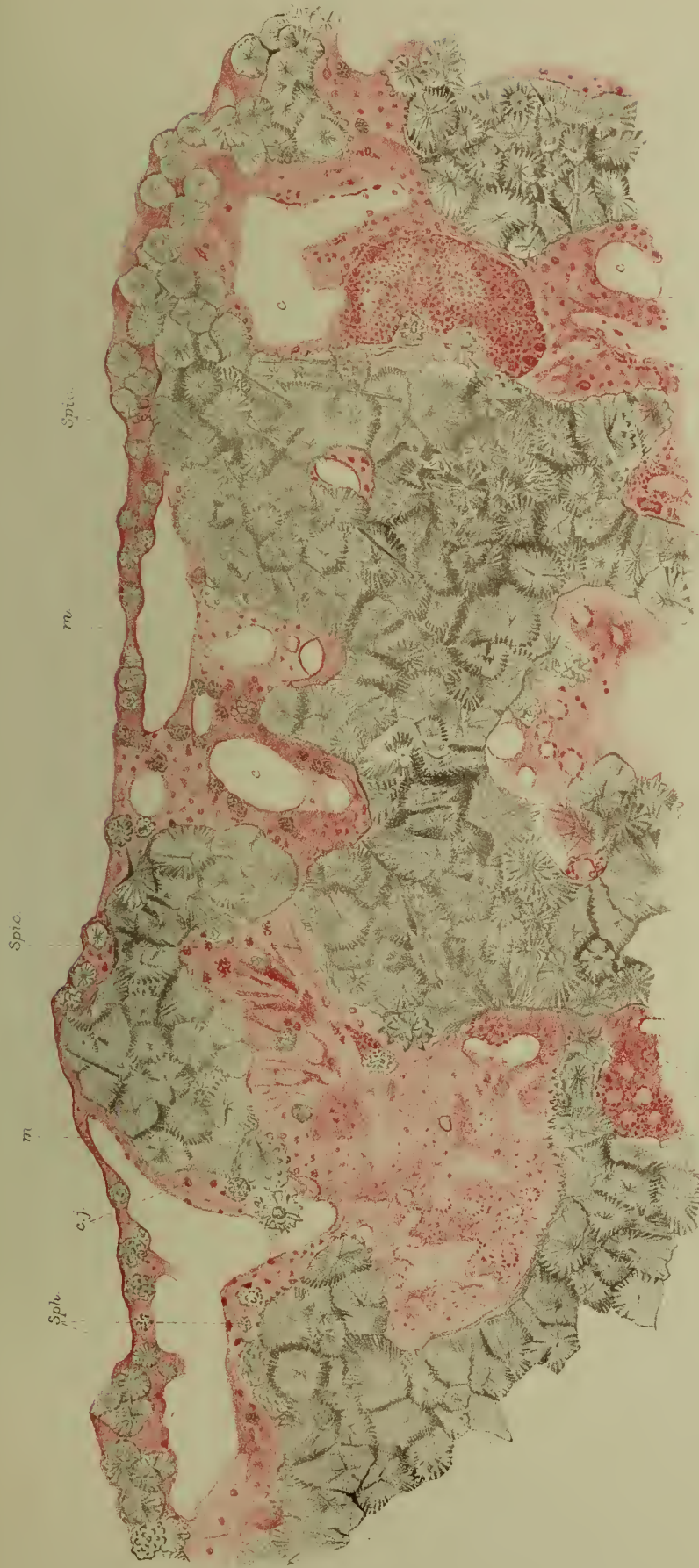
2



7



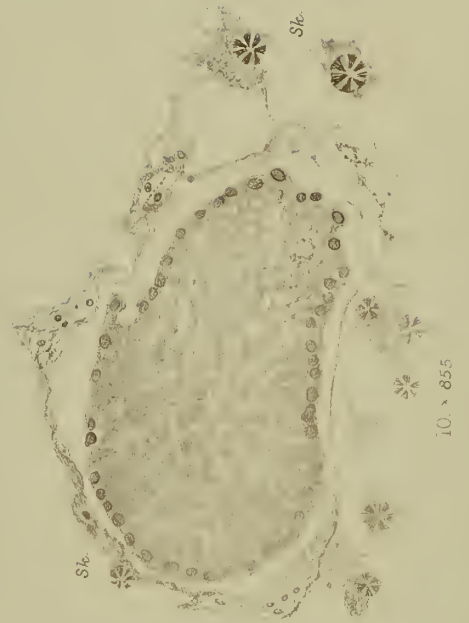
2a.



embryo

8. x 105

c. ch.

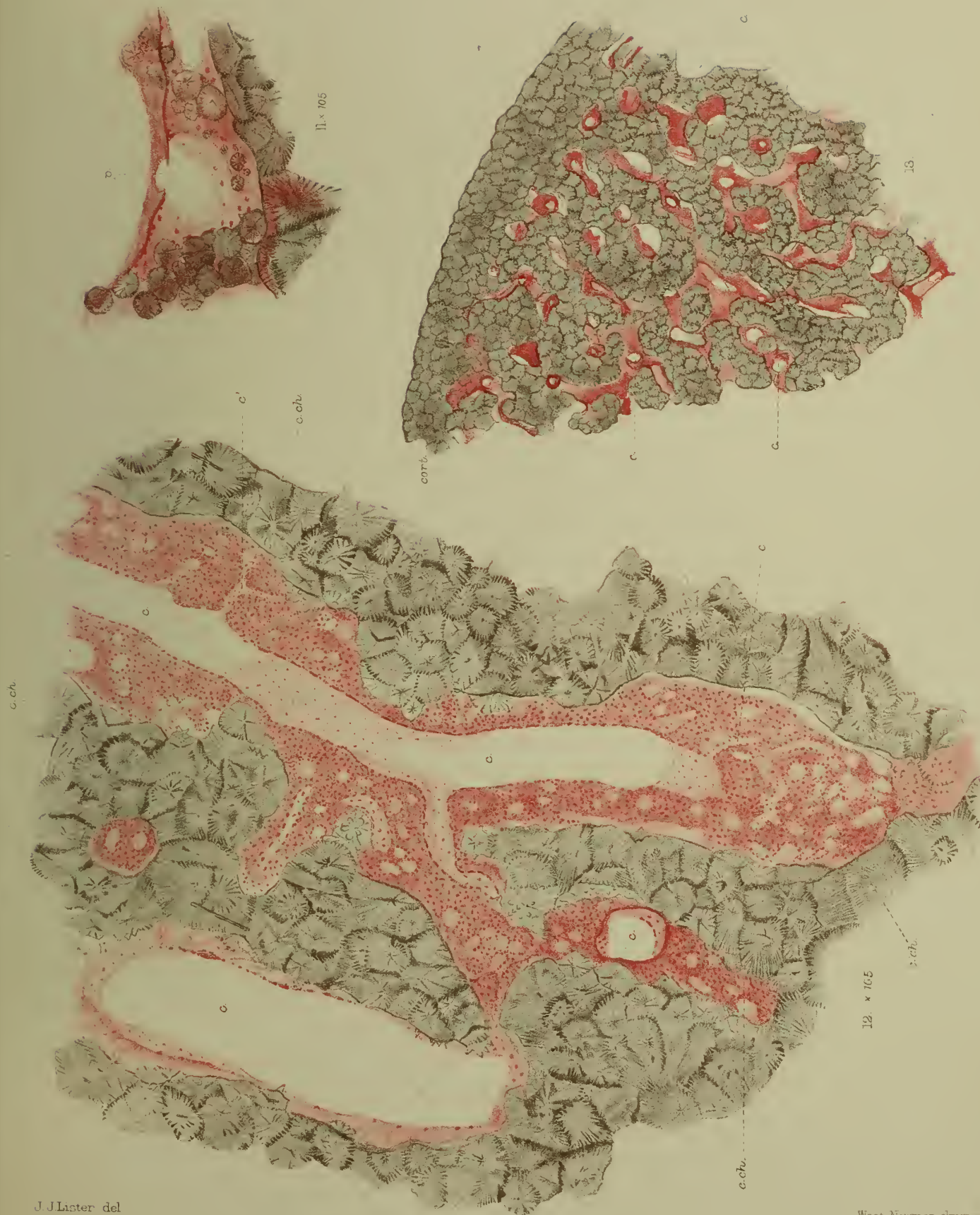


10. x 855



J.J. Lister del.

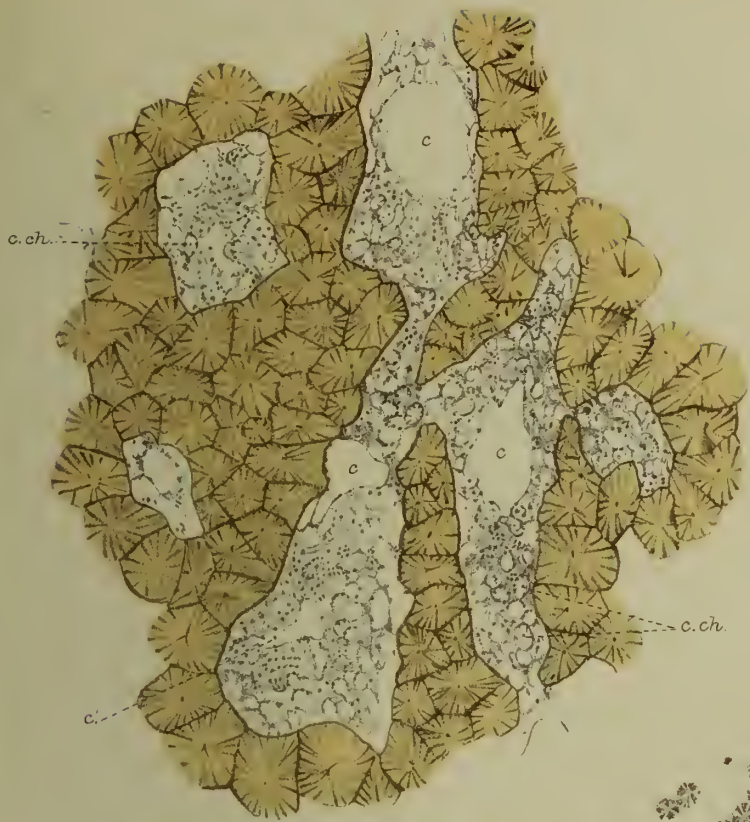
West, Newman chromo



J J Lister del

West, Newman chrom.

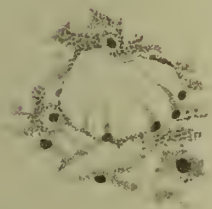
LISTER. ASTROSCLERA.



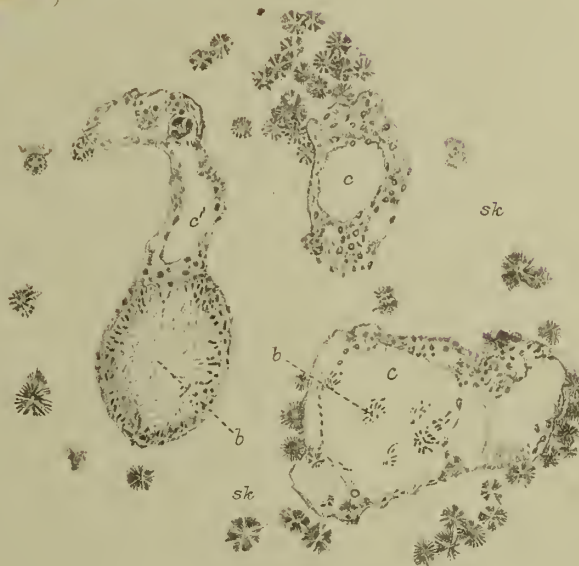
14. $\times 170$



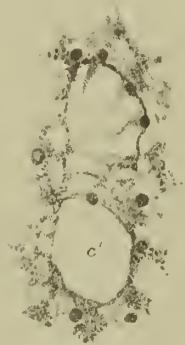
15. $\times 980$



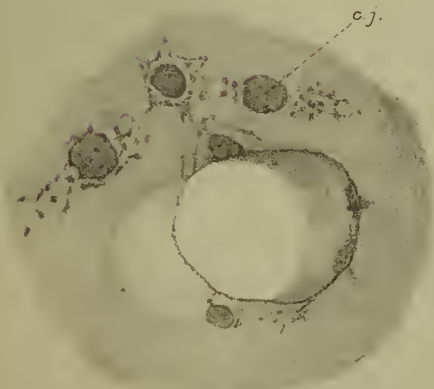
16a. $\times 980$



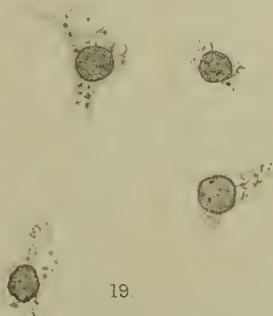
20. $\times 250$



16b. $\times 980$



18. $\times 980$



19.



17. $\times 980$

A CONTRIBUTION TOWARDS OUR KNOWLEDGE OF THE PTERYLOGRAPHY OF THE MEGAPODII.

By W. P. PYCRAFT, A.L.S.

With Plate XLIX.

I. INTRODUCTORY.

THE Megapodes included in Dr Arthur Willey's collection belong exclusively to the genus *Megapodius*. It comprises a valuable series of embryos and one newly-hatched nestling. To what species these belong it is not possible to say with certainty, except in the case of the newly-hatched chick, which is apparently *M. eremita*.

It has not been thought necessary to describe anything other than the pterylogical characters of the specimens forming the subject of this Report, these being hitherto almost unknown.

For the purposes of comparison, and for the sake of increasing the value of the present paper, I have added a description—as complete as circumstances would allow—of the pterylosis of the only adult preserved in spirit in our collection. This, being the type of *M. pritchardi*, had to be examined so as not to inflict damage. Only the main characters therefore of the adult pterylosis have been recorded; from these, however, it would appear that the differences between the adult and the embryo are but slight.

In so far as the description of the areas of the tracts is concerned it will be found that the adult of *M. pritchardi*, and the embryo (p. 487) are the same.

Besides Dr Willey's embryos, the British Museum possesses one nearly ripe *Megacephalon maleo* and a newly-hatched chick of *Megapodius eremita*, and these have proved very helpful.

It is to be hoped that in course of time the pterylosis of all the Megapodes will be described. The present claims to be the most complete yet published.

II THE PTERYLOSIS OF THE ADULT (*M. pritchardi*).

Pterylæ:—

Pt. capitis. This is a fairly evenly distributed tract, but the feathers of the forehead, and sides of the head are very small and barely conceal the skin. The inter-ramal area is not sharply defined. There are no eyelashes.

Pt. colli. This divides about half-way down the neck into a *pt. colli dorsalis* and *ventralis*. The former soon passes into the

Pt. spinalis. This tract is separable into two regions, an upper and a lower. The upper, which represents a backward continuation of the *pt. colli dorsalis*, terminates in a slightly bifurcated free end. The feathers of this region are much longer and stronger than those of the remainder of the tract.

The lower moiety of the tract is of great width, and composed of long, rather loose feathers. In the caudal region it becomes suddenly constricted and terminates at the base of the uropygium.

Pt. caudae. There are 12 rectrices. In the nestlings these are wanting.

Pt. colli ventralis. This does not appear, as a distinct tract, till about the middle region of the neck, where it forms a pair of lateral bands; these pass downwards on either side into the

Pt. ventralis. This may be divided into a pair of anterior and external, and posterior and internal tracts. The anterior are derived from a backward extension, and widening of the *pt. colli ventralis*. Each terminates near the posterior end of the breast-bone. The posterior portion of the tract may be traced from the cloacal aperture forwards as a narrow band of feathers running on either side of the middle line, to within a short distance of the level of the clavicle.

Pt. ani. The bulk of the feathers of this small tract lie caudad of the cloacal aperture.

Pt. femoralis. This is not a sharply defined tract, but merges above into the *pt. spinalis* and below into the *pt. cruralis*. The feathers along its inferior border are much larger and stronger than those of the rest of the tract.

Pt. cruralis. This tract completely invests the leg, nearly as far downwards as the tibio-tarsal joint.

Pt. humeralis. This tract is very sharply defined, except anteriorly, where it passes forwards to join the *pt. ventralis*.

Pt. alaris:—Metacarpo-digitals 10. Cubitals 15. Diastataxial¹.

The first cubital is shorter than the second but not markedly so, as in the Galli, e.g. *G. bankiva*. The carpal remex, which should probably be regarded as the real first cubital (4) is vestigial, plumaceous in character, and much smaller than its covert.

Tectrices:—

T. majores (dorsal). Those of the primaries are fairly large and strong; of the secondaries the chief point to be noticed is their relative length; unfortunately this cannot be very certainly made out in the only adult available for examination,

¹ This term is synonymous with aquitocubital.

many of these and the neighbouring series having been cut. Enough remains to show that the fifth covert is neither abruptly longer nor shorter than the sixth, as sometimes happens in diastataxial wings (10).

The major coverts of the under surface of the wing are small.

T. mediae. On the dorsal aspect of the manus these feathers are very small; they run from the second remex outwards to the tip of the wing. It is interesting to note that the sixth median cubital covert is markedly shorter than the fifth and seventh—on either side—which two are of about equal length. The overlap appears to be proximal.

This series appears to be absent on the ventral surface.

T. minores. One row of small, quite vestigial feathers on the manus, from 3—4 rows of the cubital series.

The minor coverts of the ventral aspect of the wing are small and only imperfectly clothe its surface.

T. marginales. Except along the extreme pre-axial border of the wing these cannot be distinguished on the dorsal aspect from the minor coverts.

On the ventral surface they are readily separable with (1) those which clothe the extreme pre-axial border, and point outwards, and (2) those which lie caudad of these. The latter form a single row of elongated feathers pointing backwards, and serving to clothe the patagial membrane. Moreover they entirely conceal the most anterior of the minor coverts.

The *parapteron* is small, but does not otherwise offer any points of particular interest.

The *hypopteron*; like the *parapteron* this group of feathers does not call for any special remark.

Ala spuria. This is of considerable size, the outermost and longest extends backwards as far as the free border of the major coverts of the hand.

The carpus of the adult, from which this description is taken, is armed with a thickened callous pad.

Semiplumæ. A few occur—as usual—along the borders of the *pt. spinalis*.

Plumule. These are very small, and confined to the *pt. alaris*.

Filoplumæ. One or two at the base of each of the larger contour feathers.

Rhamphotheca, simple, with a feebly-developed cere in which the nostrils are placed. These last are impervious, and open, not protected by an operculum as in *Gallinæ*.

Podotheca bare, in the form of large plates.

Claws. Absent on the wing, on the foot very long and blunt.

Uropygium, tufted.

Apteria:—

A. spinale. This is very small. In the embryo agreeing precisely with that of *G. bankiva*, of about the same age.

A. colli laterale. This divides the lower half of the *pt. colli* into dorsal and ventral moieties (p. 484); it is a forward continuation of the

A. trunci laterale. The area of the space is much restricted by reason of the great extension of the hinder portion of the *pt. spinalis*. It extends downwards and backwards, so as to divide the *pt. ventralis* from the *pt. cruralis*, and is continued forwards to the point where the *pt. humeralis* forms the *pt. ventralis*. Passing upwards, above the wing and humeral tract, it becomes the *Apt. colli laterale*.

A. mesogastræi. This lies in the mid-ventral line and extends from the cloacal aperture forwards to about the middle of the neck.

III. THE NESTLING PLUMAGE.

Dr Gadow (5) coined the word Neosoptiles, to distinguish the plumage of the nestling birds—when present—from the Teleoptiles or plumage of the adult. Later, I showed that this nestling plumage was often made up of two different kinds of down. The one preceding definitive down feathers, the other preceding definitive contour feathers. For the former I proposed the term pre-plumulæ, and for the latter pre-pennæ. Sometimes, as in the Duck, the nestling plumage consists of pre-pennæ only, sometimes, as in the case of the young Hawk, of both kinds.

The nestling Megapode possesses no pre-plumulæ, and it is doubtful whether pre-pennæ, in the sense in which this word was originally used, occur. It seems certain that the pre-pennæ representing the remiges and contour feathers generally are shed during embryonic life (see p. 488). If this proves to be true, and there seems to be room for but little doubt, we have a third form of nestling plumage—a stage between the pre-penna proper, and the actual definitive feather of the adult. In passing we might remark that this is unique only in so far as the time of its appearance is concerned; for, as the writer has already pointed out (11), the young Owl dons a special, woolly form of covering intermediate between the pre-pennæ and the definitive feathers, whilst, as already remarked, the pre-pennæ of the Megapode are lost in embryonic life, so that the young Megapode starts life in the same kind of plumage as that assumed by the young Owl later on. The structure of this nestling plumage is discussed on p. 488.

It is sufficient to remark here, that the nestling has no rectrices, and that the development of the first cubital remex, as in the nestling chick, is arrested; its place being filled by a few downy filaments—probably representing a true neosoptile. The remex probably does not appear until after the first moult of the “quills.” The wing further agrees with that of the Common Fowl, and of *Opisthocomus*—in that the development of the outer primaries is suppressed until later in life. I have discussed the significance of this in recent papers (8, 10). It is probable that in the case of the Megapode they do not, like the first cubital, appear until after the first moult. In the nestling Megapode and *Opisthocomus* there are 8 primaries, in the adult 10. In the nestling Chick there are 7 primaries, in the

adult 10. There are no claws in the wing of the nestling Megapode, but they appear for a while in the embryo.

The manus and fore-arm of the ? 6—7 day embryo are sub-equal in length, in the nestling the manus is considerably shorter than the fore-arm. This difference or change in relative length of the fore-arm and hand has been already commented upon in the Common Fowl and in *Opisthocomus*, in the paper just referred to (10).

IV. THE PTERYLOSIS OF THE EMBRYO.

In so far as the general form and proportions of the tracts are concerned, the embryo, as already remarked, does not differ from the adult. Furthermore, it is difficult, given embryos of the same relative stage of development, to distinguish between those of the Common Fowl and those of the Megapode. In the stage figured, the two forms may be certainly distinguished by the fact that, in the Fowl the wing is eutaxial and there is a rudimentary "comb," and in the Megapode the wing is diastataxial and there is no rudiment of a comb.

Concerning the diastataxial wing of this embryo (Fig. 4) I would remark only, that it does not differ materially in the form and distribution of the shifting papillæ, from the normal diastataxial wing, as recently described by me (12). There are no claws on the wing of this embryo.

The wing of a much earlier embryo than this exhibits one or two features of great interest, and, I think, importance.

In the first place, it appears to have already become diastataxial: the development of the feather papillæ is still very faintly traceable so that this point is difficult to make, nevertheless there is but little doubt that it is so. Furthermore, the post-axial border of the distal end of the fore-arm has a swollen appearance, as if the superficial growth had been faster than the deeper parts, so as to cause a tendency which would ultimately end in producing a fold. It suggests that the rate of growth of the skin, and muscular tissue below, had outstripped that of the skeleton within. This has crowded the anterior cubital remiges together, and forced the associated major coverts out of position, finally resulting in diastataxy. This swollen stage is a noticeable feature in many diastataxial wings. I do not, however, in the above facts see any reason to alter my recent explanation (12) as to the manner in which diastataxy is brought about. I should regard them rather as secondary phenomena probably not connected with the origin of diastataxy at all.

The length of the hand in this stage is less than that of the fore-arm.

This collection contains several embryos much younger than the last, and two of stages much older than that here figured (Fig. 1). With the very early stages we cannot deal in the present paper; the later stages are useful—in the present connection—only in so far as they afford material for studying the nature and development of the nestling plumage, and will be dealt with under this head.

V. STRUCTURE OF THE FEATHERS, AND THE NATURE OF THE NESTLING PLUMAGE.

Contour feathers: the structure of the adult contour feathers calls for no special remark, all the feathers of the trunk possessing a normal, well-knit, coherent vexillum. This fact, however, affords a valuable and important standard of comparison between the contour feathers of the adult and those of the nestling, and brings out one very interesting point of difference between these two stages.

The plumage of the newly-hatched Megapode will probably prove to be unique. It differs from the definitive contour feathers of the adult on the one hand, and the typical pre-pennæ, which precede these, on the other. It agrees very closely with that recently described by me (11) in the nestling Owl; in that, like this, the trunk feathers are of a loose, semiplumous character, the vexillum of the feathers being disconnected.

By a typical pre-penna, I should explain, that I take as my standard of comparison the pre-penna of the strictly Gallinaceous birds, e.g. Turkey (Pl. XLIX, Fig. 5). In this we have, microscopically examined, a distinct main-shaft, and an after-shaft, each provided with rami and radii; the latter bearing feeble fila (Fig. 11 *F.*). The after-shaft breaks up at once into rami, whilst in the main-shaft the rhachis is traceable upwards for a considerable distance.

A feather, taken from the same region of the body of a ripe embryo or of a newly-hatched Megapode chick, shows a distinct advance upon this. As will be seen in the figure (Fig. 6) the main-shaft is long and tapering, and bears numerous bilaterally arranged rami; the after-shaft likewise is well defined, and bears rami disposed as in the main-shaft. Furthermore, the rami and radii differ slightly in structure.

In the Turkey the rami were produced into fine terminal filaments beyond the last pair of radii, and the radii were seen to be provided only with feebly developed fila; this was the case no matter what part of the feather was examined.

In the Megapode the rami and radii, as in the more perfect contour feathers, differ somewhat in structure according to whether those examined are at the base or the tip of the feather. The rami from the base are long, and slender, and the radii take the form of long delicate rods bearing more or less well-marked nodal swellings or flanges at intervals (Fig. 10), which may be produced forwards into fila. The rami, from the distal end—of the main-shaft only—resemble rather those of the pre-pennæ of the young Tinamou which I described some time since (11), inasmuch as each ramus is laterally compressed at the base into a blade-like lamina, which, tapering forwards, gradually becomes segmented and rod-shaped; the fila are here constant, paired, and proceed from the distal end of each segment. These fila are the homologues of the "hooklets" of the more perfectly developed contour feathers: indeed, hooklets occur, though feeble, in the feather from which this description is taken. The nestling down feather of the Megapode, however, differs from that of the Tinamou chiefly in that the rami are somewhat weaker.

In spite of this resemblance between the nestling down plumage of the Tinamou and the Megapode, there can be no doubt that the feathers composing each differ in

one important point. The former are true pre-pennæ, the latter are something differing from, and intermediate between, pre-pennæ on the one hand and definitive contour feathers on the other. They represent apparently the adolescent plumage which we noticed was assumed in the case of the Owls (12) during their first year; but with this difference: in the Owl, these semiplumous feathers were preceded by true neossoptiles, in the shape of pre-pennæ; in the young Megapode they are not: for these feathers are probably only to be found upon the embryo, as will be seen below.

The above facts raise a most interesting question concerning the life history of the Megapodes. For it may now be asked: If the plumage of the young Megapode is not made up of Neossoptiles—or pre-pennæ and pre-plumulæ in the strict sense of the word—but of a something intermediate between pre-pennæ and the definitive contour feathers of the adult, is the development of these neossoptiles entirely suppressed or rather entirely eliminated ontogenetically?

The material represented in this collection will I think afford an answer to this question, but more specimens, and in a slightly better state of preservation, will be necessary before it becomes absolutely convincing. For my own part, I have no doubt at all, and would reply that the development of pre-pennæ has been almost totally eliminated, though transitory rudiments still make their appearance.

These can well be studied in the ripe embryo, in which they appear as long straw-coloured filaments depending from the tips of the remiges.

Under the microscope, these filamentous processes prove to be the sheath of the outer Malpighian layer, which invests the developing feather. Through this the rudiments of rami can be plainly seen. These are apparently quickly disintegrated, but the capsular sheath remains unbroken, until thrust out, upon the tip of the definitive feather replacing it, and from which it is ultimately cast off. Normally, this sheath would have been broken up and dispersed by the developing rami of the pre-penna, which, later, would have been carried out on the tip of the definitive feather destined to replace it. In the present case, as we have just seen, the rami never attain strength—or bulk—sufficient to burst this investing sheath, which remains, for a season, in the place of the pre-penna dissolved within it, attached to the tip of the definitive feather, which has superseded it.

In younger embryos, in that stage in which the feathers look not unlike much elongated Porcupine quills, it will be noticed that each of these “quills” becomes slightly constricted near the tip, swelling out again distad of the constriction, and then tapering rapidly to a point (Fig. 7). I take it that this constriction occurs at what was once the base of a pre-penna, and that the swollen, distal end of this “quill” represents all that now remains of it. A comparison of Figs. 7—8 will make this clearer. Fig. 7 represents the “quill” stage just referred to; in this the rami of the definitive feather seem clearly distinguishable from the fine rami that I take to be remnants of pre-pennæ. Fig. 8 is a later stage, drawn from one of the “straw-coloured” filaments from the tip of a remex. Fig. 9 shows the pre-penna of a Turkey attached to the distal end of the rami of a definitive feather.

One of the most striking features of the ripe embryo, whereby it is seen to differ at once from all known birds, is the great length of the remiges, and their

coverts, which lie on either side of the body like a series of long closely packed camel-hair pencils—the tips of the feathers having already burst the investing sheath in which they were enveloped—extending backwards to the extreme end of the body. It is in the stage earlier than this, before the tip of the sheath has burst, that the rudimentary pre-pennæ are found.

SUMMARY.

As stated in the earlier part of this paper, this is the first attempt at anything like an extended or detailed account of the Pterylography of the Megapodes, and even this leaves much still to be done.

The only other record of the pterylogical characters of this group is that of Nitzsch (6). He was perforce obliged to content himself with an examination of a stuffed specimen. In spite of the difficulty of such an unsatisfactory method of investigation, he managed to make out enough to show him "it possesses the general characters of the Gallinaceæ," and that the oil-gland was tufted.

Since then the additions to our knowledge of this subject have been few, and chiefly concern the fact that the young chick is enabled to fly almost immediately after leaving the egg.

The most important of these is that of Dr Gadow (2), who writes: "Die Jungen, wenigstens einiger Arten, schlüpfen vollständig befiedert und flugfähig aus; das Nestkleid ist also embryonal unterdrückt worden."

Dr Sclater (13) was apparently the first to point out, on the authority of Mr Beddard, that the wing of at least one species of Megapode (*M. rubrifrons* = *eremita*) was "aquintocubital" = diastataxial.

The more or less precise details of the pterylogical characters of the adult and embryo given in the present contribution will it is hoped be shortly supplemented by similar descriptions of other genera. The facts embodied in this part of the paper are really all new. Again, no one appears to have previously noticed the facts concerning the arrested development of the outermost primaries, and of the 1st (2nd) cubital remex in the nestling, or the differences in the rate of growth of the manus and fore-arm. All these points, it is interesting to notice, the young Megapode shares with the young *Gallus* and *Opisthocomus*.

The history of the pre-pennæ still needs further investigation. That the nestling was not clothed in a covering of true nestling down has been more or less accepted as a fact for a long while, but the difference between this nestling plumage and definitive feathers seems not to have been previously remarked.

One or two problems concerning the development of feathers generally have been raised during the present investigation. These however do not concern the questions of pterylosis at all, and will be dealt with in due course.

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EXPLANATION OF PLATE XLIX.

FIG. 1. Lateral view of the left side of an embryo *Megapodius eremita*, showing the form of the ptery læ. The dotted areas represent ptery læ; the relative sizes of the feathers are indicated by large and small dots.

<i>Apt. coll. lat.</i>	Apterygium colli laterale.
<i>Apt. m.</i>	Apterygium mesogastrœi.
<i>Pt. cap.</i>	Ptery la capitis.
<i>Pt. caud.</i>	Ptery la caudalis.
<i>Pt. coll. dors.</i>	Ptery la colli dorsalis.
<i>Pt. coll. vent.</i>	Ptery la colli ventralis.
<i>Pt. cr.</i>	Ptery la cruralis.
<i>Pt. f.</i>	Ptery la femoralis.
<i>Pt. hum.</i>	Ptery la humeralis.
<i>Pt. sp.</i>	Ptery la spinalis.

FIG. 2. Dorsal view of the same. The dotted parts as before.

<i>Apt. sp.</i>	Apterygium spinale.
<i>Apt. t. lat.</i>	Apterygium trunci laterale.

FIG. 3. Ventral view of the same.

FIG. 4. Dorsal aspect of right wing of embryo (Fig. 1) showing the first appearance of the feather-papillæ representing the remiges and major coverts of the fore-arm. The arrangement is seen to be diastataxial.

<i>c. c.</i>	Carpal covert.
<i>c. r.</i>	Carpal remex.
<i>i. c.</i>	Intercalary coverts.
<i>med. c.</i>	Median coverts.
<i>mj. c.</i>	Major coverts.
<i>min. c.</i>	Minor coverts.
<i>7th c. r.</i>	7th cubital remex.

FIG. 5. A pre-penna of a nestling Turkey. To show the after-shaft, and widely separated radii. Note the filamentous ends of the rami.

<i>A.</i>	After-shaft.
<i>D. f.</i>	Definitive feather.
<i>Rd.</i>	Radius.
<i>Rm.</i>	Ramus.

FIG. 6. A feather from a nestling Megapode. This should be contrasted with Fig. 5.

FIG. 7. Portion of a definitive feather supporting a rudimentary pre-penna from a late embryonic stage of *Megapodius eremita*.

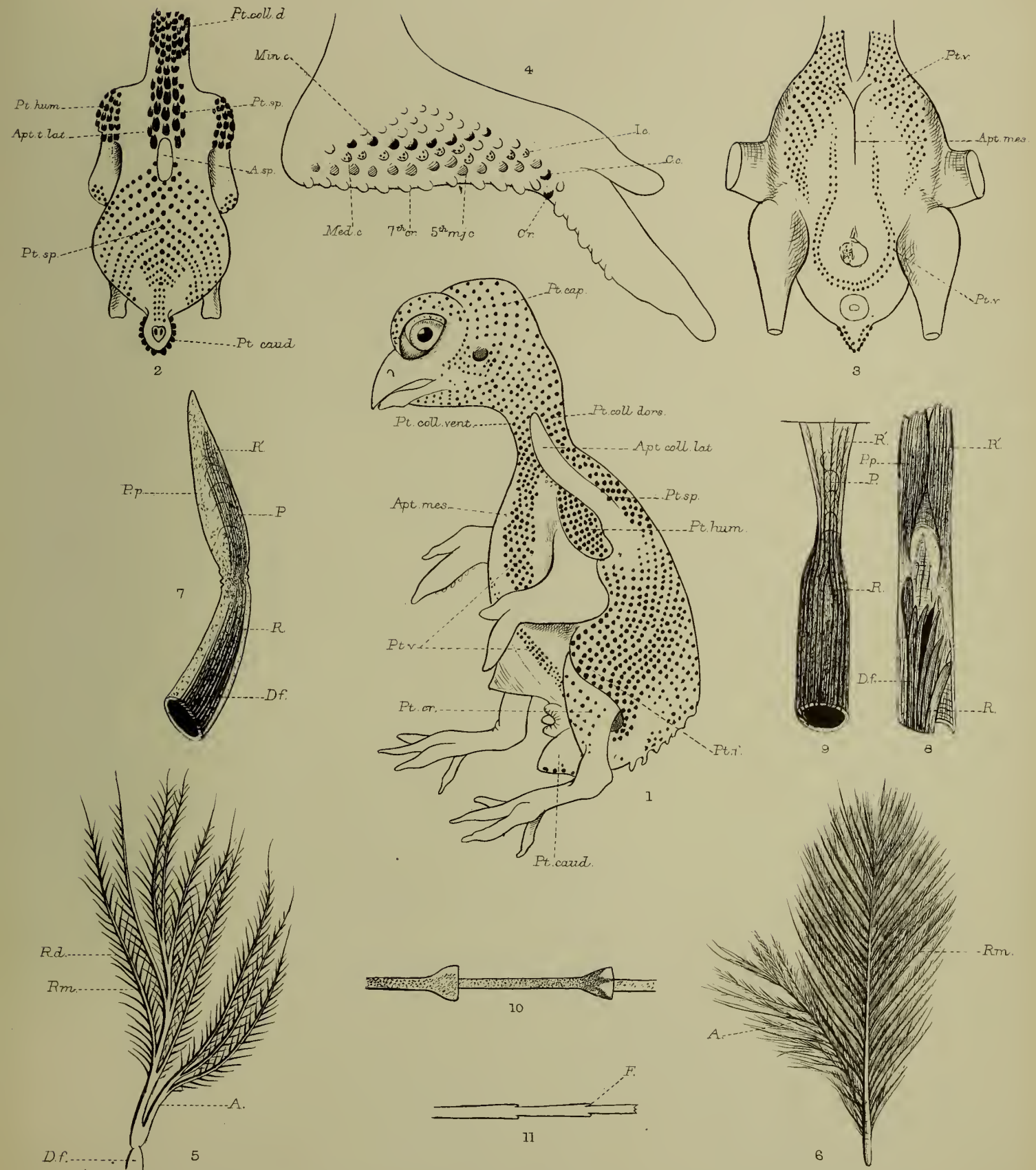
<i>D. f.</i>	Definitive feather.
<i>P.</i>	Pith cells.
<i>P.p.</i>	Pre-penna.
<i>R.</i>	Rami.

FIG. 8. Portion of a definitive feather with rudimentary pre-penna from a ripe embryo of same species as Fig. 7.

FIG. 9. Portion of a definitive feather of a nestling Turkey, supporting a pre-penna, the distal portion of which has been removed. The rami of the pre-penna have burst the investing sheath and are now free.

FIG. 10. Portion of a radius from the base of a feather from a nestling Megapode.

FIG. 11. Portion of a radius from the pre-penna of a nestling Turkey. *F.* = Fila.



W.P. Pycraft del. adnat.

PYCRAFT. MEGAPODIUS.

West, Newman lith.

THE STOLONIFERA AND ALCYONACEA COLLECTED BY
DR WILLEY IN NEW BRITAIN, ETC.

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With Plates L. and LI.

STOLONIFERA.

1. *Tubipora musica*, L.

A single specimen well preserved in spirit of this widely distributed species was sent to us. It was obtained at Welle Island, D'Entrecasteaux group. Attention has already been called by one of us (7) to the unsatisfactory nature of the evidence for dividing the genus into a number of species, and the comparison of both hard and soft parts of this specimen with specimens obtained by Dr Gulliver in Zanzibar and by one of us in Celebes confirms the opinion previously expressed that there is only one species of the genus. The principal character which has been used for distinguishing species is the diameter of the polyp walls, but this character in every specimen depends entirely upon the situation on the reef in which it happened to grow. It is what would be called in modern phraseology "an acquired character," and there is no evidence that it is one which is inherited as all true specific characters may be. The tubes happen to be in this specimen 2.5 mm. in diameter, but there can be little doubt that if Dr Willey had collected specimens from different localities great variations would have been found in this character.

If we accepted the current views on the species of *Tubipora*, Dr Willey's specimen would be called *T. rubeola* Q and G (20). In describing their new species these authors say that compared with *T. musica* "les tubes sont plus gros, plus long, légers, moins serrés et offrant cylindres de deux à trois pouces sans nœuds." It is true that the distance between the platforms does not amount to more than 10 mm., but the specimen is a young one and in other respects resembles the description of *T. rubeola* Q and G.

The anatomy of *Tubipora* has already been fully described (12 and 8) but it seemed desirable, since Dr Ashworth (1) has shown that there is a marked divergence from the general anatomical features of the Alcyonarian stomodaeum and mesenterial filaments in the genus *Xenia*, to reinvestigate the structure of these organs in *Tubipora*.

The stomodaeum possesses an ectodermal epithelium of clear columnar cells as in *Alcyonium* and other forms, and there is a well-marked siphonoglyph armed with long cilia. No gland cells are found in this epithelium. There are six short ventral mesenterial filaments bearing gland cells. These filaments begin on the free edge of the mesenteries in contact with the inner opening of the stomodaeum. In the contracted spirit specimens they may be seen to extend about 5 mm. down the free edges of the mesenteries. It is impossible to estimate what their exact length may be in the living expanded polyps. The two dorsal mesenterial filaments are very much convoluted and extend from the stomodaeum as far down as the first tabula. There are no gland cells in their epithelium.

Judging from these anatomical facts then, the digestive processes of *Tubipora* must be carried on as in *Alcyonium* and *Kophobelemnion*, the digestive fluid being secreted by the six ventral mesenteries and not in any degree by the epithelium of the stomodaeum nor by the epithelium of the dorsal mesenterial filaments.

The specimen was a male. The young sperm sacs in their follicles were found on the six ventral mesenteries only, as described and figured by von Koch¹.

2. *Clavularia viridis* Q and G.

A small piece of a colony of this species was sent to us in a partially retracted condition. It was obtained at Welle Island (Sanaroa), D'Entrecasteaux group, in 1895.

The specimen differs from those obtained in Celebes (9) in being decidedly stouter in build. The polyps are not very long (about 35 mm.), springing from a creeping stolon attached to a piece of dead coral. The terminal extremities of the polyps have an inflated appearance due, undoubtedly, to the manner in which they were killed. They are from 40—50 mm. in length and 8 mm. in diameter at the free end. Only one transverse tubular connection between the polyps above the level of the stolon was seen.

The spicules vary considerably in length but the average is about 2.5 mm. The tubercles are rather less prominent than those of the spicule figured by one of us (9), but similar to those of other spicules in the collection from Celebes.

In the larger spicules of Dr Willey's specimen there may be frequently seen a curious bifurcation of one end. The same has been noticed in the Celebes specimens. The lower, and therefore older, parts of the body wall are strengthened by the formation of horny fibres in the mesogloea, making the texture hard and brittle.

¹ On referring to my preparations made in 1884 I find that I was in error in the statement I made then that the gonads occur on the dorsal mesenteries in the specimen from Zanzibar.

It is extremely probable that Dana (2) was mistaken in stating that the specimen he examined was hermaphrodite, six of the mesenteries bearing sperms and two ova. Hermaphroditism is of very rare occurrence in Alcyonarians and the presence of gonads on the dorsal mesenteries has not yet been satisfactorily proved in any genus. S. J. H.

The dorsal mesenterial filaments extend from the free edge of the stomodaeum to the stolon. They are considerably convoluted and drawn out laterally into long tag-like processes (Fig. 14). The six ventral mesenterial filaments are short, beginning some distance from the free edge of the stomodaeum as shown in Fig. 13. The gonads (the specimen was a female) occur below the ventral mesenterial filaments and are attached to all six of the ventral mesenteries. Numerous nematocysts (0.01 mm.) were observed in the peristome. They are spindle-shaped, with very fine points.

There can be no doubt that Dr Willey's specimen belongs to the same species as that originally described by Quoy and Gaimard from Vanikoro, as the specimen obtained from the Aru islands by Wallace (now in the British Museum) and as those which occur on the reefs of Celebes. It is very similar in some respects to the specimen described as *Clavularia inflata* by Schenk (24), and it is quite probable that Schenk's specimen was but a young form of this species.

Now that we know something more of its anatomy it may seem to be an open question whether it would not be advisable to constitute a new genus for this species, the principal characters of which would be the tubular connections between the body walls of adjacent polyps in large specimens, the horny fibres of the mesogloea, the large spicules, the tag-like processes of the dorsal mesenterial filaments and the remote position of the ventral mesenterial filaments. We do not propose however to give it a new generic name in this paper, although we wish to emphasise the fact that the species stands very much apart in the genus. It is a matter of some regret that owing to the manner in which the polyps contracted when killed they are not sufficiently well preserved to give good results of cellular histology. We are not able therefore to say for certain whether gland cells occur in the dorsal mesenterial filaments and in the stomodaeum or do not. All that can be said is that the histology is apparently very different from that of *Tubipora* and that the matter is well worthy of further investigation. It may be mentioned for the guidance of collectors that when polyps exhibit an inflated appearance after death they are usually distended with sea-water and practically sealed to the preserving fluid in which they are immersed. Such polyps should be slit open and placed in fresh spirit or the endoderm will macerate and the specimens be useless for histological investigation.

ALCYONACEA.

The specimens collected by Dr Willey, which belong to this sub-order, have proved to be of considerable interest.

There are two species of the genus *Telesto*, one of which is new, two species of *Nephthya*, and five species of *Spongodes*, one of which is new.

The sub-family Siphonogorginae is represented by one species of the little known genus *Chironephthya*.

The Alcyonidae are represented by four species of *Alcyonium*, of which one is new, three species of *Sarcophytum* and four of *Lobophytum*.

The representatives of the Xenidiidae are five in number, one being new to science. They are described in a separate paper by Dr Ashworth.

3. *Telesto rupicola*, Müller (Pl. L., Figs. 1, 2).

There is one specimen of this species, the upper portion of which is thickly covered by a commensal sponge through which only the polyp's tentacles protrude. The branches of the basal stolon are from 15—20 mm. in length by 1 mm. in diameter.

There is one main axial polyp, 90 mm. long by 2 mm. in diameter. It bears three secondary axial polyps, all on the same side; the first 18 mm. long is borne 52 mm. from the base of the axial polyp; 64 mm. above this is the second, 8 mm. long; the third is 8 mm. above the second, and is 16 mm. long.

The axial polyp also bears lateral polyps at intervals of from 2—4 mm.; they are irregularly placed round the axis. The stolon bears several independent polyps, and the secondary axial polyps bear tertiary polyps (Fig. 1).

The expansible portion of the polyps is 5 mm. long (the tentacles being 3 mm. long)¹. There are no spicules in the tentacles but there are eight small groups of a few narrow spindles extending from the bases of the tentacles a short distance down the polyp. The body wall of the non-retractile part of the polyp is filled with spicules. All the polyps are expanded in the specimen. The primary and secondary axial polyps are of the same type. The calyx walls are marked by eight longitudinal grooves.

The spicules are long, narrow, spiny spindles, often branching at one end, thus becoming Y shaped (Fig. 2).

The spiny spicules are .607 mm. × .11 mm.—.22 mm. × .092 mm. (including the spines); the branched forms are:—the main stem .368 mm. by .092 mm., one branch .092 mm., the other .184 mm.; from the tip of one branch to that of the other, .276 mm.

The spicules are colourless. The colony is brownish-white in colour in spirit.

Habitat. Blanche Bay, New Britain. Depth, 50 fathoms. Previously recorded from the coast of Brazil, and Bahia (19).

4. *Telesto arthuri*, sp. nov. (Pl. L. Figs. 3, 4. Pl. LI. Fig. 12).

A single specimen, incomplete at the base, differs in such a marked degree from any species of the genus that has been described that we have found it necessary to constitute for it a new species, which we propose to name after its discoverer, Dr Arthur Willey.

There are three branches in the specimen (Fig. 3), the longest being 55 mm. in length and 4 mm. in diameter. Numerous polyps contribute to the substance of each branch; the difference in this respect between our new species and *Telesto rupicola* being very striking, as may be seen by comparing Figs. 1 and 3. The portions of the polyps which project from the branch are arranged in an irregular spiral, and each one inclines to the branch at an angle of 45°. The projecting portion of each

¹ The necessity for the introduction into the literature of the Alcyonaria of some term to express that part of the polyp which can be expanded and retracted is obvious. Mr G. C. Bourne has proposed in a paper read before the Linnaean Society to call it the "Anthocodia," but as Mr Bourne's paper is not yet published we do not intend to adopt it here.

polyp consists of two parts; a part which can be completely retracted and a part which owing to the constitution of the wall cannot be retracted. In the specimen the first named part of each polyp was retracted, and we cannot give any estimate of its length in consequence. The non-retractile portion of each polyp however projects about 2 mm. from the branch and is about 1 mm. in diameter. The substance of the branches is fairly soft, the coenenchym being leathery in consistency, strengthened at its periphery by long, minutely warted spindle-shaped spicules (Fig. 4). These spicules vary from 3·3 mm. \times 27 mm. to 1·3 mm. \times 18 mm.

Habitat. Blanche Bay, 30 fathoms.

This species differs from all the other species of the genus which have been adequately described, in the size and character of the spindle-shaped spicules and in the feature that the polyps are numerous and crowded. The absence of longitudinal grooves distinguishes it from *Telesto riisei* (Duch. and Mich.) and *T. arborea* (W. and S.).

Anatomical structure (Pl. LI. Fig. 12). On making a transverse section through one of the branches, it may be seen to be perforated by a number (8–10) of polyp cavities arranged in a definite manner as regards the axis—the dorsal side of each polyp, indicated by the dorsal mesenterial filaments, being turned towards the axis as in other Alcyonarian colonies. The mesogloea is moderately thick and is penetrated by numerous endodermal canals (c.c.). These canals are in all cases of small diameter, no large endodermal canals such as we find in *Xenia* (1) and in some of the Gorgonacea being found in this genus. The canals communicate with the polyp cavities, and from the fact that the polyp cavities communicate with these canals at their proximal ends, as they do in *Alcyonium*, it is probable that they give rise to the young buds. The polyp cavities do not communicate with one another directly. The substance of the mesogloea also contains a number of small bipolar cells, but the preservation of the mesogloea is not in a sufficiently satisfactory state to allow us to follow the histology into further details.

It can be positively stated that there is no axis of any kind, not any axial canal comparable to the axial canal of *Coelogorgia*. Notwithstanding the resemblance to a Gorgonacean, therefore, that this species of *Telesto* may be considered to have, it is unquestionably Alcyonacean. The specimen is a female but the gonads are probably very immature.

FAMILY. NEPHTHYIDAE.

This family is represented in Dr Willey's collection by several specimens which belong to the genera *Spongodes* and *Nephtya*.

The genus *Spongodes* appears to be fairly well-defined and is widely distributed in the shallow waters of the tropics of the Old World. A great many species have been described based upon such characters as size, colour, form and the character of the spicules. Many of these so-called species appear to be very closely related, and it is possible that on a revision of the genus based upon anatomical details many of the specific names will have to be struck out of the list. The genus *Nephtya* presents us with many difficulties, and not the least of these is that some

authors still separate the species *without* supporting bundles of spicules in the calices from those *with* such bundles, into a separate genus called *Ammothoa*.

This is one of several instances in the Alcyonaria of genera based solely on the character of spicules, and considering the well-known range of variation in both the number and shape of spicules in individual species of Alcyonarians, it is most desirable that such generic names should be discountenanced.

But the name *Ammothoa* ought to disappear altogether from the Class, on the ground that it was introduced by Leach in 1814 for a Pycnogonid (and is still used in that sense) before it was used for an Alcyonarian. It is really remarkable that the authors of the Challenger volume on Alcyonaria, knowing this fact, should still retain the term *Ammothoa* for an Alcyonid. It is difficult to see how such a course can be defended.

SUB-FAMILY I. SPONGODINAE.

5. *Spongodes cervicornis*, Wright and Studer.

This specimen agrees in general form and method of branching with the type specimen (28). The arrangement and size of the spicules is also the same. They are 4.3×1.8 mm., 5.5×3.1 mm.— 7.3×0.3 mm., $.1 \times 0.18$ mm.

The polyp heads are .8 mm. long. The colour of the main stem, branches and polyp heads is whitish, the twigs are purple.

Habitat. Sandal Bay, Lifu.

Previously recorded from Tahiti.

6. *Spongodes hemprichi*, Klunzinger.

There are two specimens of this form, the larger of which is 72 mm. in height; the stalk is 35 mm. high and 20 mm. wide. The spicules on the branches are large, opaque, white spindles covered with compound-tuberculate warts. These spindles are transversely placed and are 4.8 mm. by .55 mm. in diameter.

The polyp heads are in clusters; each has a spicule projecting above the head. These spicules resemble those of the branches. Some of the spicules of the stalk show a tendency to branching. They are 1.9 mm. long \times .33 mm.— $.33 \times .07$ mm.

The colony is brownish-drab in colour; the polyp heads are brown. Some of the spicules of the heads show a tendency to brown coloration, but the majority are white.

Habitat. Sandal Bay, Lifu.

Previously recorded from the Red Sea (11).

7. *Spongodes rhodosticta*, Wright and Studer.

There is one specimen of this species.

The total height of the colony is 90 mm. The length of the stalk is 25 mm. and its width is 3 mm.

The branches are on an average 10 mm. long. The polyps are 2—3 mm. in length, and the heads 1 mm. in diameter.

Habitat. Talili Bay, New Britain.

Previously recorded from the Arafura Sea (28).

8. *Spongodes semperi*, Studer (Pl. L. Figs. 5, 6, 7).

There are several fragments and one small colony of this species.

The stalk is thick and cylindrical, widening out a little at the top.

From the upper end it gives off a ring of six conical branches, two of which each bear a small branch. The branches stand out almost horizontally, so that they form a shallow cup at the top of the stalk.

Each is covered with closely set, spirally arranged, fairly large polyp heads which are surmounted by one or two long spicules. The branches acquire the form of spikes.

The trunk is 11 mm. high and 11 mm. wide. The diameter of the crown of branches is 26 mm. The branches are 10·14 mm. long, by 3·5—4 mm. broad.

The whole colony is rigid; the walls of the trunk are filled with long, thin, slightly curved spindles closely covered with small warts and variously placed. The same spicules are found in the branches and polyps, mingled in the latter with smaller ones of the same type.

In some cases one, and in others two, of the long spicules extend throughout the length of the polyp and project about 1 mm. beyond the head. The spicules are from 4 mm. long by ·02 mm. broad, to ·06 mm. long by ·005 mm. broad.

The colour in spirit is white.

This form agrees fairly closely with Studer's (25) description of *Spongodes semperi*. The points of difference are the absence of the polyp-covered circular fold described by Studer and of branches in the middle of the head.

Habitat. Sandal Bay, Lifu. Depth 30 fathoms.

Previously recorded from the Philippine Islands (25).

9. *Spongodes rakaiyae*, n. sp. (Pl. LI. Fig. 11).

According to Kükenthal's classification (17) of the genus *Spongodes* this belongs to the third group *Divaricatae*, sub-group *Cylindratae*, in which sub-group he includes seven species. Of the seven species the form to which this specimen seems most closely related is *Spongodes klunzingeri* Studer (*Sp. ramulosa* Klz.).

The colony is 200 mm. high, and 130 mm. wide; the main stem is 23 mm. thick; the primary branches are from 30—95 mm. long; the twigs are 12·20 mm. long.

The stem is free from branches for 35 mm. above the base, at which point it bears a thick branch 70 mm. long; 20 mm. above this branch arise two large branches, one on each side, one 70 mm. long, the other 95 mm. long. From that point the stem bears several smaller branches from 30—70 mm. long. For 75 mm. from the tip the stem bears twigs covered with polyps. Below that point the stem is quite free from polyps, which are borne on twigs springing from the branches only.

Each twig bears from 15 to 30 polyps. The twigs arise close together on all sides of the branches and gradually get smaller towards the tips of the branches, so that the latter have a conical shape. The polyp heads are not closely pressed against the twigs but each has a short peduncle, and as each polyp stands out stiffly owing to the bundle of long spicules supporting it, one of which projects for a short distance (·5 mm.) beyond the polyp head, the twigs have very much the appearance of small thorny branches.

The polyp peduncles are about 1.2 mm. long, the heads are .7 mm. high and .6 mm. in diameter.

The spicules of the polyps are slender, spindle-shaped, and covered with fine small spines. They are .31–.11 mm. long by .03–.01 mm. broad. Small rod-like spicules are arranged transversely in two irregular rows up the back of the tentacles for their whole length.

The spicules which form the bundle supporting the polyp head are long, spindle-shaped, and covered with small spines. They are from 1 to 2 mm. in length.

The upper portion of the stalk is loosely covered with large, warted, spindle-shaped spicules which lie in all directions on the surface. They are 2 to 3.8 mm. long and .18 to .21 mm. broad.

The lower portion of the stalk contains a number of irregular, knobbed spicules covered with warts. They are .42–.2 mm. long and .18–.07 mm. wide. The colony is pale fawn colour in spirit. The spicules are colourless.

Habitat. Straits of Rakaiya, Blanche Bay, New Britain. Depth, 3–4 fathoms.

The species to which this form seems most closely allied is *Spongodes klunzingeri* Studer (25) (*Sp. ramulosa* Klz.). It differs from it however in one or two points.

In *Sp. klunzingeri* the spicules of the polyps cause them to be of a red colour. In this form the spicules are colourless. The colony is much more branched and the twigs also are more divided than in *Sp. klunzingeri*.

The spicules of the polyp head are not so regularly arranged *en chevron* as shown by Klunzinger in his figure (Taf. III. Fig. 2) and do not project beyond the retracted tentacles. The spicules of the upper portion of the stem are smaller than in *Sp. klunzingeri*, where they are 3–5 mm. long. Also the spicules are all more slender and regular than Klunzinger figures them. Consequently it seems best to call this form a new species.

10. *Nephthya chabrolii*, Klunzinger.

There is one fairly complete colony with two fragments.

The colony is 45 mm. high and 70 mm. by 40 mm. wide. The stalk is 20 mm. high. It divides into four main branches, which bear numerous lateral branches and these may again divide into branchlets. The ends of the branchlets are crowded with round polyp heads and look like short blunt spikes. The large branches are 20–30 mm. long and 15–30 mm. wide. The branchlets are 2–10 mm. long, 4–8 mm. wide. The heads are 1 mm. high.

The spicules agree closely in form and size with Klunzinger's species (11).

The colour is pale fawn. The colony is female, but the ova are immature.

Habitat. China Straits, British New Guinea.

Previously recorded from the Red Sea.

11. *Nephthya virescens*, Sav.

This form belongs to the section of the genus called *Ammothoa* by Savigny and other authors, as there is no definite "Stützbundel" and the polyps are arranged in "catkins." There are three large specimens of this form, two complete, one with the basal part missing.

The larger of the two complete specimens is 225 mm. high and 90 mm. wide.

The main stalk is 20 mm. in diameter at the base. The extreme basal part is fairly rigid but the rest of the colony is soft and flabby. There are three branches springing from the base which form small stalks of the same type as the main stalk. The main stalk soon gives off various small branches ranging in length from 10—50 mm. These bear small branchlets on which the polyps are so closely crowded as to form spikes. At a distance of 120 mm. from the base is one large branch 70 mm. in length which gives off several secondary branches about 15—35 mm. long. The tip of the stalk is crowded with small spike-like branches.

One of the colonies has the basal part missing and is more branched than the other two, the main stalk giving off three large branches which reach to the top of the colony and bear numerous small branchlets covered with polyps.

There are no polyps borne directly on the main stalk or on the primary branches; they are all borne in closely crowded spikes on secondary small branches.

The spikes are from 7—10 mm. long. The polyps are non-retractile but bend in towards the branch on which they are borne. They are 1 mm. long; the heads are .5 mm. in diameter.

The polyps contain a few irregularly placed spicules, spindle-shaped and bearing a few small spines which have a tendency to become more numerous and larger at the ends of the spicules. They are .6—1.6 mm. long and .03—.01 mm. broad. The tentacles contain two irregular rows of transversely placed small rod-like spicules. The stalk contains a number of spindle-shaped spicules covered with fairly large conical warts; some of these spicules are slightly curved and the warts are decidedly larger on the convex side.

These spicules are 1.02—1.8 mm. long and .18—.09 mm. broad.

The stalk also contains some small, four-rayed forms and some very rough, knobbed forms with a small constriction in the middle, so that they look like small dumb-bells with very short shafts, and the heads very irregular in shape and covered with warts. They are .27—1.3 mm. by .21—.12 mm. The colonies are pale brown colour in spirit. The spicules are colourless.

Habitat. Straits of Rakaiya, New Britain. Depth, 3—4 fathoms.

The figures given by Haeckel in his "Arabische Korallen" 1876, and Klunzinger (11) of *Ammothea virescens* (Sav.) are not by any means alike, but Dr Willey's specimens closely resemble in form the specimen obtained by Haeckel. The spicules correspond with the figures given by Klunzinger (Taf. II. Fig. 4).

SUB-FAMILY II. SIPHONOGORGINAE.

12. *Chironephthya scoparia*, Wright and Studer.

There are only two small fragments of the ends of branches. The larger is 18 mm. long by 2 mm. in diameter and has 10 polyps arranged spirally. The polyp heads (as in *Spongodes*) are bent down so that the group of long spicules projects beyond the head. Each fragment has three polyps near the apex, one being terminal.

The tentacular operculum and the collaret agree with Wright and Studer's description (28). The contracted polyps are 1.5 mm. in length and 1.5 mm. in diameter.

The spicules agree in form and size with the description of those of the type specimen. The branches are yellow and the polyp heads red in colour.

Habitat. Talili Bay, New Britain.

Previously recorded from the *Hyalonema* ground, 345 fms., Japan. The occurrence of this species in shallow water off New Britain and in deep water on the *Hyalonema* ground is a very noteworthy fact in distribution.

FAMILY. ALCYONIDAE.

Wright and Studer (28, p. 238) are of opinion that only those fleshy Alcyonids found in the cold and temperate sea should be included in the genus *Alcyonium*, those found in the tropical seas being referred to the genus *Lobularia*.

As these authors have pointed out (28, p. xxi) there is great difficulty in distinguishing *Alcyonium* from Savigny's genus *Lobularia*. It is true that many of the tropical species have large spicules which cause the cortex to have a leathery consistency when compared with the cortex of the species of the cold and temperate seas; but there appear to us to be many reasons why this feature should not be regarded as one of generic importance. In this collection there are three specimens which are so remarkably similar to the European species *Alcyonium glomeratum* that it would be absurd to place them in a distinct genus. We agree therefore with Klunzinger and others in not recognising the genus *Lobularia*.

A word of explanation may be made here as to the use of the term stalk in the following pages.

In the genus *Sarcophytum* the colony assumes a form which has not inaptly been compared to that of a mushroom; there is indeed a well-marked differentiation of the upper part or head from the lower supporting part or stalk. The important morphological difference between the two parts is that the expansible portions of the polyps, called for the sake of brevity polyp heads, protrude from the capitulum but do not protrude from the stalk. In some genera of Alcyonidae, such as *Alcyonium* and *Nephthya*, the head and stalk are not so sharply differentiated as in *Sarcophytum*, and in the literature of the subject several terms such as "barren part" or "sterile portion" have been employed for what is morphologically equivalent to the stalk of *Sarcophytum*. In our opinion any expression which implies barrenness or sterility in the part named is misleading and consequently we use throughout the term "stalk" for the part of the colony which does not bear polyp heads.

13. *Alcyonium polydactylum*, Klunzinger.

The colony has apparently been split in two and only one half is in the bottle.

It is 85 mm. high; the stem is 55 mm. long by 35 mm. wide, the head is 30 mm. high by 70 mm. broad and is much divided.

There are five main branches, each of which bears several branchlets on which the short, obtuse, somewhat finger-like processes are crowded.

The main branches are 20—40 mm. long and about 20 mm. wide; the processes are 5—10 mm. long and 3—6 mm. wide. The polyps are scattered over the entire surface of the head at intervals of 1—2 mm.

The spicules agree fairly closely with Klunzinger's figures and description. The long, warted spindles are from .5—2.3 mm. long and .12—0.6 mm. wide. The small clubs are from .12—1.3 mm. long and .04—0.7 mm. wide.

The colony is fawn colour in spirit.

Habitat. China Straits, British New Guinea.

Previously recorded from the Red Sea (11).

14. *Alcyonium glomeratum*, Hassall.

There are two complete colonies and one fragment of a species of *Alcyonium* in the collection, which appears to be closely related to our British *Alcyonium glomeratum*. They are small, the largest being only 45 mm. in height and 22 mm. wide, and probably young specimens. Of course we can form no estimate as to the size they might have grown to when adult.

The larger colony of the two complete ones is pale yellow in colour but here and there at the polyp heads there may be seen red spots, due probably to clusters of red spicules. The smaller colony is bright orange-red in colour. The fragment is intermediate in colour between the two.

In this variation in colour the specimens agree with the European varieties of *A. glomeratum*.

The spicules are of the same general character as those of the European forms. In the coenenchyma there are some spicules found which are dumb-bell in shape and the long spindles are larger and apparently more numerous than in the British form. The Talili spicules are 0.4 mm., the British 0.2 mm., in length. A statement (10) has been made that in *Alcyonium glomeratum* dumb-bell shaped spicules are not found. If this statement turned out to be true for all European specimens it would not in our opinion be sufficient ground for the constitution of a new species for the Talili specimens which undoubtedly possess them. The spicules of a common species such as *Alcyonium digitatum* may vary immensely in size, shape and colour according to the depth and locality from which they are taken, and unless we have a long series of specimens to judge from, it is unwise to speak confidently about the characters of the spicules.

The facts that the spicules are of the same general form as those of the European specimens, show similar variations in colour, that the lobes of the colony are pointed and deeply divided, and that the polyps are of the same size and (in the retracted condition) of the same appearance, are sufficient when taken together to justify this determination.

Habitat. Talili Bay, New Britain.

Previously recorded from coasts of Great Britain and Norway.

15. *Alcyonium pachyclados*, Klunzinger.

There are two small, complete colonies of this form, the larger is 50 mm. by 35 mm. across the capitulum and 15 mm. high. The general appearance, the arrange-

ment, shape and size of the "lappets" correspond with those of Klunzinger's specimens. The spicules agree closely in size and shape.

The colour in spirit is grey.

Habitat. Blanche Bay, New Britain.

Previously recorded from the Red Sea (11).

16. *Alcyonium macropodium*, n. sp. (Pl. L. Figs. 8, 9, 10).

There is one colony of this form. It exhibits a pronounced stalk which is 40 mm. high by 20 mm. and 15 mm. in thickness; the capitulum consists of numerous short, pointed lobes bearing a few large polyps; it is 45 mm. in length and 20 mm. in diameter. The lobes are about 5 mm. long.

The spicules are warted spindles with a tendency to branch at one end. There are a few small clubs and four-rayed forms. The spindles vary in size; they are $2.12 \times .368$ mm., $1.75 \times .24$ mm., $.736 \times .184$ mm., $.257 \times .073$ mm., $.147 \times .055$ mm. The four-rayed forms are $.163 \times .147$ mm.

Habitat. Blanche Bay, New Britain.

This species differs very markedly from others of the genus in the long thick stalk and short branches. These characters with the form and size of the spicules suggest that it must belong to a distinct species.

17. *Sarcophytum ehrenbergi*, Marenzeller.

There is only a fragment of the capitulum 70 mm. long by 35 mm. broad. It is about 10 mm. thick, fairly soft; the edges bend down somewhat over the stalk in the form of two small folds. The autozooids are not very close to one another (7—10 in 1 cm.); the pores of the siphonozooids are very minute.

The spicules agree closely in form and size with those described and figured by Marenzeller (18).

The colour in spirit is a dirty grey.

Habitat. China Straits, New Guinea. Previously recorded from the Red Sea, Port Denison (Australia), Viti Islands.

18. *Sarcophytum fungiforme*, Schenk.

There is one small colony of this form, complete.

The stem is 20 mm. high and 15 mm. in diameter, the capitulum is 33 mm. by 25 mm. and 5 mm. thick. There are two deep folds on one side meeting in the centre of the capitulum. On the other side the capitulum bends down somewhat over the stalk. The folds are 20 mm. high.

The position and number of the autozooids and siphonozooids per cm. agree with Schenk's description (24).

The spicules resemble closely in form and size those described and figured by Schenk. The colour of the colony in spirit is greyish.

Habitat. Blanche Bay, New Britain.

Previously recorded from Ternate.

19. *Sarcophytum glaucum*, Marenzeller.

There is one complete colony; the stalk is 40 mm. long and 15 mm. in diameter; the capitulum is 45 mm. by 45 mm. and 3—5 mm. thick. The whole is decidedly soft and the capitulum is flabby.

The arrangement of the folds, the distribution of the autozooids and the form and size of the spicules agree closely with Marenzeller's description (18).

Colour in spirit is brown, the polyps fawn.

Habitat. Blanche Bay, New Britain.

Previously recorded from Tonga Islands and Port Denison and Port Bowen (Australia).

20. *Lobophytum pauciflorum*, Ehrenberg.

There are two fairly large specimens, but the basal attachments are missing. The larger is 50 mm. in height; the stalk is 30 mm. high and 70 mm. broad; the head is 105 mm. in diameter. It is a somewhat darker brown than the smaller colony.

Habitat. Talili Bay, New Britain.

Previously recorded from the Red Sea, Amboina and New Zealand (5, 18).

21. *Lobophytum marenzelleri*, Wright and Studer.

There are two portions of colonies; the larger is 75 mm. in width; the basal part is missing.

The whole is very firm and rigid.

The capitulum corresponds closely with the description in the Challenger report (28) as regards the lobation; it is very hard and packed with very large spicules. The surface is rough on drying.

The autozooids are scattered over the lobes and where retracted are visible only as small pores.

The siphonozooids are difficult to see even with a lens. The colour is pale fawn. The spicules are of about the same length as in the type specimen but are much narrower. The proportions are: 4.08 mm. long by .552 mm. wide; 2.85 mm. \times .46 mm.; 1.65 mm. \times .33 mm.; .736 mm. \times .165 mm.; .514 mm. \times .035 mm.

The small branched clubs are .147 mm. by .064 mm.

Habitat. Near Cape Gazelle, New Britain.

Previously recorded from Api, New Hebrides. 60—70 fms. (28).

22. *Lobophytum densum*, Whitelegge.

There is one colony, the basal part of which is missing. It is 70 mm. by 45 mm. across the head and 40 mm. high.

The lobes are 5.25 mm. high, by 4—8 mm. in their narrow and 7—15 mm. in their broad diameter. The autozooids are about 1 mm. apart. The siphonozooids are difficult to find even with a lens.

The colony is hard owing to the large number of spicules present. The tuberculated spindles are from .8—2.1 mm. long by .17—.31 mm. wide. The spiny spindles are from 1.1—2.2 mm. long by .12—.26 mm. wide. The small clubs are .13 \times .03 mm.

The colour is brown with rather darker furrows and pits.

Habitat. Sandal Bay, Lifu; and China Straits, British New Guinea. Previously recorded from Funafuti, Ellice Islands (30).

23. *Lobophytum crassum*, Marenzeller.

There is only a fragment of the capitulum of this species measuring 30 mm. by 25 mm. It shows four thick folds. The spicules of the cortex are somewhat larger than those of the type specimen (18).

The spicules of the coenenchyma are slightly smaller; they are .23—.29 mm. long and .07—.09 broad. But they are of the same type as those figured by Marenzeller.

Habitat. Loyalty Islands.

Previously recorded from Port Denison (Australia).

ADDENDUM.

Since the above paper was sent to the press my attention has been called to a memoir by Walther May entitled "Beiträge zur Systematik und Chorologie der Alcyonaceen" in the *Jen. Zeits. f. Naturwiss.* xxvi. 1. None of the species described by us as new agree with the new species described by May. There is no reason to believe therefore that there is any serious overlapping.

I may point out however that *Clavularia flava* cannot be accepted as the name for the new species described on his page 43, as I employed this name for a species from Australia described in the *Trans. Zool. Soc.* Vol. XIII. 1895.

S. J. HICKSON.

Feb. 21, 1900.

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EXPLANATION OF PLATES L. AND LI.

FIG. 1. *Telesto rupicola*. Colony $\times 2$. The upper portion is covered by a commensal sponge through which the expanded polyps project.

FIG. 2. Spicules of *Telesto rupicola*.

FIG. 3. *Telesto arthuri*, n. sp. Colony $\times 2$.

FIG. 4. Spicules of *Telesto arthuri*. $\times 16$. a. end of spicule showing size of warts. $\times 112$.

FIG. 5. *Spongodes semperi*. Colony $\times 2$.

FIG. 6. *Spongodes semperi*. Tip of branch, showing arrangement of spicules.

FIG. 7. Spicules of *Spongodes semperi*.

FIG. 8. *Alcyonium macropodium*, n. sp. Colony $\times 1$.

FIG. 9. *Alcyonium macropodium*. One polyp contracted showing valve-like folds (*v.*) which can be drawn over the folded tentacles.

FIG. 10. Spicules of *Alcyonium macropodium*.

PLATE LI.

FIG. 11. Polyp head of *Spongodes rakaiyae*, n. sp., to show the arrangement of the spicules.

FIG. 12. A diagrammatic transverse section of a branch of *Telestoa arthuri*. In the centre are four large coelenteric cavities (*p. c.*), the tubes of polyps borne close to the part of the branch from which the section is taken.

The four smaller coelenteric cavities somewhat to the outside of these are polyp tubes cut nearer to their point of origin; the polyp tubes become smaller as they are traced down the branch. The dorsal mesenteries (*d. m. f.*) with their filaments extend the whole length of the polyp tubes, and traces of some of the lateral and ventral mesenteries are usually seen in section. The dorsal mesenteries are on the side of the tube nearest to the axis.

Ova (*ov.*) are found attached to some of the lateral mesenteries.

The mesogloea between the polyp tubes contains numerous small endoderm-canals, but these do not extend to the surface of the branch (*c. c.*).

Two polyps are shown cut across. One (*t. s.*) is a transverse section of the polyp just below the stomodaeum, showing the large bundles of muscle fibres on the mesenteries which however extend only for a very short distance down the tube, and the mesenteries become mere little projecting lumps of mesogloea covered by a thin layer of endoderm cells continuous with the layer lining the polyp tube.

The other polyp (*l. s.*) is cut longitudinally and shows two retracted tentacles and the stomodaeum in longitudinal section.

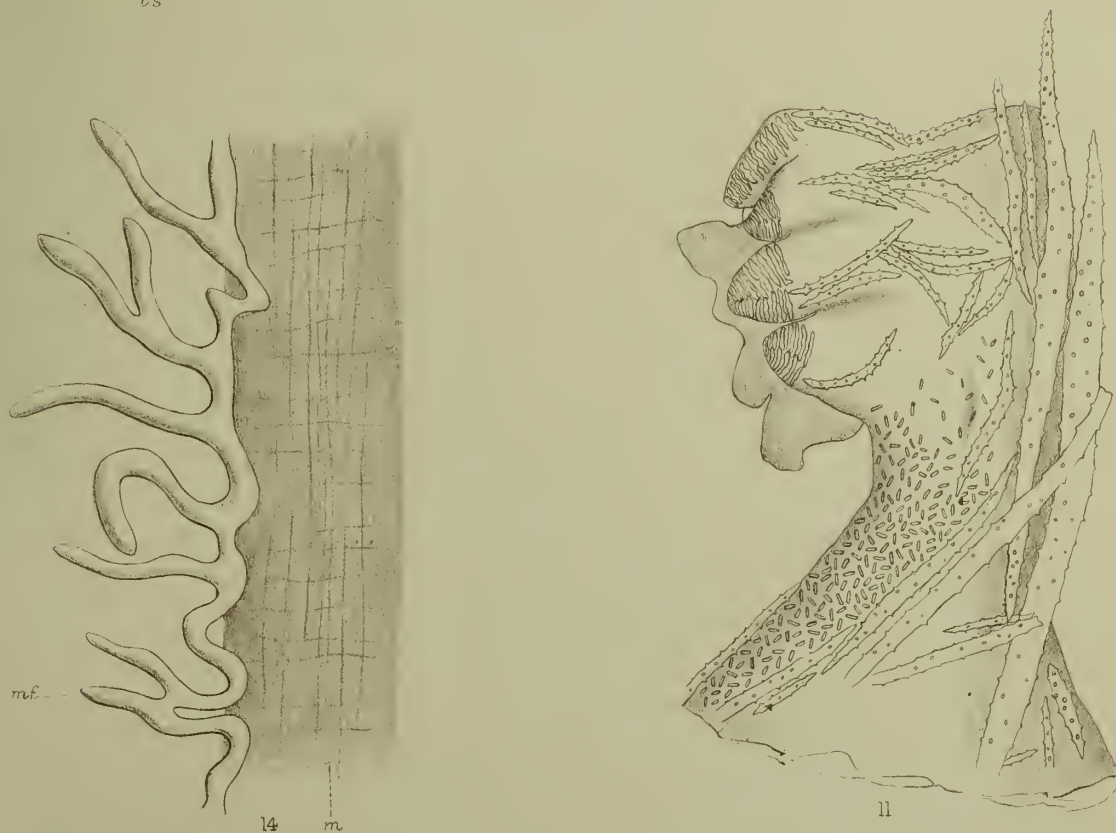
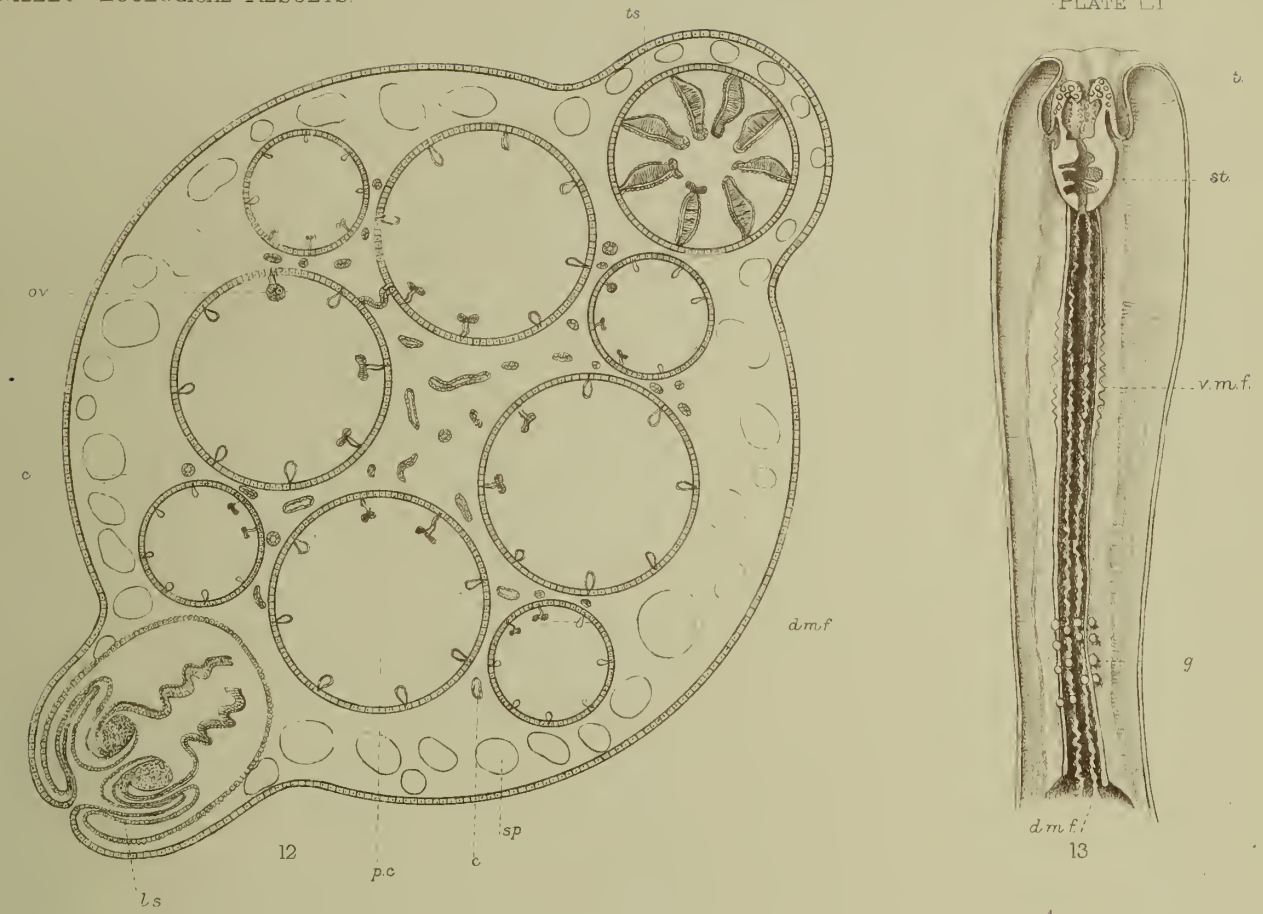
The large cavities near the edge of the section represent the cavities occupied in nature by the spicules.

FIG. 13. A retracted polyp of *Clavularia viridis* as seen when cut longitudinally in half. *v. m. f.*, the ventro-lateral mesenterial filaments commencing some distance from the stomodaeum; *d. m. f.*, the dorsal mesenterial filaments extending the whole distance from the stomodaeum to the base; *g.*, the gonads; *t.*, tentacle; *St.*, Stomodaeum.

FIG. 14. A portion of a dorsal mesentery of a polyp of *Clavularia viridis* enlarged to show the form of the dorsal mesenterial filament (*d. m. f.*).



HICKSON AND HILES. ALCYONACEA.



West, Newman lith

REPORT ON THE XENIIDAE COLLECTED BY DR WILLEY.

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With Plates LII. and LIII.

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Dr Willey's collection of specimens of the genus *Xenia* contains fifteen colonies which may be referred to five species.

Of the sixteen species of *Xenia* hitherto described eight were founded by Schenk (1896)¹ upon specimens brought from Ternate (Moluccas). Three of the specimens in Dr Willey's collection belong to three of these newly described species, which are now recorded for the second time only. One of the other two species is moderately well-known, being, in fact, the first described species of *Xenia* (*X. umbellata*, Savigny); the other species is new and is represented in the collection by eight specimens. Thus although four of the species have been previously described three of them have hitherto been met with only once, and as all the specimens are of considerable interest a brief description of each is given below.

¹ The dates in brackets form references to the list of papers given on p. 528.

The specimens referred to the three species *X. umbellata*, *X. crassa*, and *X. membranacea* differ in one or more characters from the specimens described as typical of those species, but the differences are certainly not of sufficient importance to justify the formation of new species. For example, the differences between the specimen which is referred to the species *X. crassa* and the type specimen described by Schenk, may be accounted for by the fact that Dr Willey's specimen is a young colony the polyps of which have not yet acquired their adult size and characters, while Schenk's was probably a more mature colony. It is therefore important to examine and record the condition of the genital products of a colony in order that it may be ascertained whether the polyps are, or are not, adult. Some of the differences between Klunzinger's specimen of *X. umbellata* and the colony of this species in Dr Willey's collection may also be attributed to differences in age (see p. 515), while others, *e.g.*, the form of the colony, may be due to the influence of dissimilar habitat upon the mode of growth. It seems reasonable to suppose that specimens obtained from the Red Sea (as was Klunzinger's *X. umbellata*) and from New Britain may be subjected to rather different external conditions, which may have an influence upon the colony, producing variation in its general form, the stoutness of its polyps, etc. The photographs contained in Professor Hickson's Report on the specimens of *Millepora* collected by Dr Willey show how many different forms or facies may be assumed by a single species. Some attention has been devoted to the anatomy of each species, but as they all agree in their main features with *X. Hicksoni*, the anatomy of which has been described in detail (Ashworth, 1899) only a few notes on their structure are appended. Important confirmation has been obtained of all the chief features described in *X. Hicksoni*, with the exception of the giant flagella, which do not appear to be present in any of these species. The most important point confirmed is certainly the absence of ventral and lateral mesenterial filaments in which the polyps of *Xenia* and *Heteroxenia* differ from those (autozooids) of any other Alcyonarian hitherto described.

XENIA CRASSA. SCHENK.

This species is represented by a small and probably young colony, the single unbranched stem of which is thick, soft and fleshy and somewhat knob-shaped, its polyp-bearing summit being convex. The height of the stem is 10 mm.—11 mm.; its diameter at the base is 10 mm. and at the summit 15 mm.

The polyps¹ are short and stout and stand close together, especially round the edge of the summit of the stem. The measurements of the larger polyps are—body of the polyp 3 mm. long and 1·5 mm.—2 mm. broad (a very few polyps are 2·5 mm. in breadth), tentacles 2·5 mm.—3·2 mm. long and ·7 mm.—1·2 mm. wide. Each

¹ In order that the measurements and characters given below may be compared with those given by previous authors, the word polyp is used, in this and in similar connections in this paper, in the same sense as these authors have used it, *viz.*, to indicate the free or exsert portion of the polyp. It should be remembered however that this is not the whole of the polyp, a considerable portion of it is enclosed in the stem from the summit of which the free portion of the polyp projects, indeed a primary polyp (*i.e.* one of the first formed polyps of the colony) extends down to the base of the colony. (See Plate LII. Fig. 7.)

of the somewhat short and wide tentacles bears on its inner face three rows of pinnules on each side of the middle line. There are nine to twelve pinnules in each row. In the majority of the polyps the pinnules occupy the whole of the inner face of the tentacle with the exception of a small area in the middle line near the base. The pinnules, which are rather stout and conical, are .5 mm.—.7 mm. in length and .2 mm. in width.

Besides these well-developed polyps there are many buds or young polyps in various stages of development. These are situated not only round the outer edge of the polyp-bearing summit of the stem, where they are most usually found in other *Xeniidae*, but are also scattered over the convex end of the stem between the bases of the larger and older polyps. The buds are, however, much more numerous round the edge of the convex disc, there being about thirty polyps less than one millimetre in length situated around this edge. In the youngest polyps, the length of which is .4 mm., the tentacles are indicated by eight small rounded elevations separated from each other by slight grooves. In slightly older polyps .7 mm. long the tentacles are simple rounded wart-like elevations .3 mm. high. The first pinnules appear when the tentacles of the polyp attain a length of about .4 mm., and from this stage onwards there is a gradual increase in the number of pinnules along with the increase in length of the tentacle, *e.g.* a tentacle .5 mm. long shows when seen from the outer aspect three pinnules on each side of the middle line, a tentacle .75 mm. long shows five pinnules, one .9 mm. long shows six pinnules, &c.

The disc-like spicules are extraordinarily numerous, and in many parts they are in contact with or even overlapping each other. They are whitish by reflected light and either light yellow or light reddish-brown by transmitted light. Most of them are oval in shape but some circular ones are present. They are .018 mm.—.024 mm. in length and .015 mm.—.018 mm. in breadth.

The stem of the colony is light yellow-brown, slightly tinged with green in the upper part, the polyps are a much lighter shade of the same colour. The greyish-white colour of the tentacles and pinnules is probably due in a great measure to the light reflected from the very numerous spicules present in those parts.

The specimen is a male but the gonads are small. The sperm sacs are recognisable as spherical swellings on the edges of the six ventral and lateral mesenteries, but the largest sacs present are only .08 mm. in diameter, and are obviously in an early stage of development, the cells which they contain having undergone comparatively few divisions. These sacs are similar to the largest of the three of *X. Hicksoni* represented on Pl. 27, Fig. 30 (1899).

Two large polyps were stained and cleared. The stomodaeum of these polyps is about .9 mm. long, and the wall of each shows a considerable number of small light areas which probably indicate the presence of swollen empty cells similar to those which have been described in the stomodaeum of *X. Hicksoni* (1899, p. 251).

Habitat:—Isle du Phare Reef, Noumea, New Caledonia.

The specimen agrees in most respects with the diagnosis of *X. crassa*, Schenk (1896, p. 58), but the dimensions of the polyps of Dr Willey's specimen are about two-thirds those of Schenk's specimen and the number of pinnules on the tentacles differs

in nearly the same proportion (9—12 in each row in Dr Willey's, 15—18 in Schenk's). These differences are probably due to the fact that this specimen is a young colony the polyps of which have not yet grown to their full size and the tentacles of which have not yet acquired the full number of pinnules. (This is supported by the condition of the genital products described above.) In spite of these differences the characters of the colony, *e.g.* the shape and character of the stem, the form and structure of the polyps, the shape of the pinnules and the extraordinary abundance of spicules, are in close agreement with the corresponding characters of Schenk's species.

This species has been previously recorded from Ternate (Moluccas).

XENIA MEMBRANACEA. SCHENK.

This colony consists of two almost equal and parallel stems arising from a common basal membrane which is attached to the two branches of a V-shaped piece of dead madrepor. The membrane which has spread out over the adjacent surface of the madrepor is thickest around the bases of the stems, becoming gradually thinner towards its free edge, where it is about a millimetre thick. The stems are 15 mm. long and 10 mm. in diameter, and 18 mm. long and 9 mm. in diameter respectively. The free end of each stem is slightly convex and bears the polyps, which are numerous and closely packed together, often being somewhat flattened by mutual pressure.

The polyps are moderately long and have a slender appearance. The body of each polyp is 5 mm.—10 mm. in length (a very few reach 12 mm. in length) and .8 mm.—1.2 mm. in breadth. The tentacles are also long, slender and pointed, being 4.5 mm. — 7 mm. in length and about .4 mm.—.8 mm. broad. The inner face of each tentacle bears rather long and thin pinnules, which are arranged, but not very clearly, in six rows. The pinnules generally occupy the whole of the inner face of the tentacle, but in a few polyps the middle line of the tentacle for a short distance from the base is free from pinnules. There are, on an average, 16 to 18 pinnules in each row, but in some of the longest tentacles there are 24 in each row. In the middle of the tentacle, where they are largest, the pinnules are .5 mm.—.6 mm. in length and about .1 mm. in breadth.

In this specimen also buds are present but they are much fewer in number than in the preceding colony (*X. crassa*). They are found *only* on the edge of the polyp-bearing summit of each stem. The smallest is .4 mm. long and its tentacles are but faintly indicated. In a bud .6 mm. long the tentacles are finger-shaped lobes .25 mm. long, while in a polyp 1 mm. long they have attained a length of .35 mm. but none of them yet possess pinnules. A young polyp 1.4 mm. long has advanced considerably, as its tentacles are .6 mm. long and show two or three pinnules on each side of the middle line of the tentacle (seen from the outer aspect), while a young polyp 2.5 mm. long bears tentacles 1.3 mm. in length, each of which shows on its outer face 6—7 pinnules on each side of the middle line.

The spicules are round or oval discs .012 mm.—.018 mm. in length and .01 mm.—.012 mm. in breadth. They are either yellowish or slightly bluish-white by reflected light and many of them show iridescent colours. By transmitted light the spicules

are yellowish-brown. They are present in moderate numbers in the stem, but are more numerous in the body of the polyp and in the tentacles, and still more numerous on the outer face of the pinnules, but there are comparatively few on the inner face of the pinnules.

The specimen is dark brown, its colour being due partly to the spicules and to the contained zooxanthellae and partly to the colour of the soft tissues.

The stomodaeum of the larger polyps is 1.7 mm.—1.9 mm. in length.

On examining in spirit the surface of the ectoderm of the polyps, numerous minute refringent oval bodies are clearly visible. Most of these bodies are imbedded in, and their long axes are at right angles to the free surface of, the ectoderm. These are very probably nematocysts. They are .008 mm.—.009 mm. in length and .0025 mm. in diameter, thus agreeing very closely with the nematocysts of *X. Hicksoni* (1899, p. 258), which are .008 mm. long and .002 mm.—.003 mm. in diameter.

The specimen is apparently a male, but the sperm sacs are very few in number and very small in size, and are obviously in an early stage of development. They are rather oval and the largest measure only about .05 mm. along their greater diameter.

Habitat. New Britain.

This specimen agrees with the description given by Schenk of *X. membranacea*. The general characters of the stem and polyps agree with the diagnosis of the species very well indeed; the polyps and tentacles of Dr Willey's specimen are rather larger than those of the type specimen, but their general proportions are almost identical. Schenk's species derived its name from the basal membranous expanse which bound together the bases of the stems. A similar basal membrane is present in Dr Willey's specimen but is developed to a less extent, probably owing to the different mode of attachment of the colony. Schenk's specimen was attached to a sandy (and probably flat) substratum which would offer favourable opportunities for the formation of the basal membrane.

Previously recorded from Ternate (Moluccas).

XENIA UMBELLATA. SAVIGNY.

There are three colonies referable to this species.

I. The basal portion of the largest colony encrusts a piece of weathered coral rock. From this rather thick membranous base (which is 2 mm.—3 mm. in thickness) three stout fleshy stems arise, the largest of which is about 33 mm. high and 30 mm. \times 15 mm. at the base. At a distance of about 10 mm. from the summit this stem is divided into a larger and a smaller branch by a deep fissure. The stem next in point of size is 25 mm. long and measures 15 mm. \times 15 mm. at the base. The smallest of the three stems of this colony is 20 mm. high and 15 mm. \times 13 mm. at the base. All the stems increase slightly in diameter as they ascend. The summit of each stem is a flat or slightly convex area from which the polyps arise.

II. The second colony is also attached at the base to a piece of worn coral rock. It consists of a single stout fleshy stem about 25 mm. high and 23 \times 13 mm.

at the base. The stem widens as it ascends and its breadth at the summit is 33 mm. \times 16 mm. The polyp-bearing area is slightly convex. The base of the colony is prolonged downwards at the edges, forming an almost hemispherical cap which is closely applied to the rock on which the colony is fixed.

III. The smallest colony consists of a single stem about 15 mm. long and about 12 mm. \times 10 mm. at the base.

The polyps arise moderately close together on the end of each stem. The bodies of the fully developed ones are 5 mm.—10 mm. long (a few reach 13 mm.) and 1.2 mm.—1.8 mm. wide. The tentacles are long, being 5 mm.—8 mm. in length and 1.3 mm.—1.6 mm. broad, and bear on each side of the middle line three rows of pinnules of about 22—29 in each row. The pinnules are long and slender, .5 mm.—.8 mm. in length and 1 mm.—1.2 mm. in width. The inner face of each tentacle presents an area free from pinnules. This area is about .4 mm. wide at the base of the tentacle, gradually narrows towards its tip, and is no longer recognisable in the distal fourth of the tentacle; in this region the pinnules of the two sides are in contact at their bases.

Buds are found not only round the edge of the summit of the stem but also scattered over the whole of the summit between the bases of the older polyps. Those round the edge of the summit are similar to the buds found in other species of *Xenia* (Pl. LIII. Fig. 10), except that the young polyp is 1.6 mm.—1.8 mm. long and its tentacles have reached a length of nearly 1 mm. before the first pinnules appear upon them. In the other species of *Xenia* the pinnules appear when the polyp is much smaller and its tentacles are only .4 mm.—.6 mm. long. There are on the ends of two of the large stems three small areas in each of which four or five buds are found. Several of these buds differ from the normal buds present round the edge of the summit of the stem, the body of the former being much larger in proportion to the tentacles than is usual. One of these buds is represented in Fig. 12. Its total length is 5 mm., its stout finger-shaped, rather unequal tentacles are only 1.0 mm. to 1.3 mm. long. Three of them are trilobed at their tips, i.e. there is an indication of the formation of the first two pinnules, one on each side of the axis of the tentacle. Another similar bud 6 mm. long has slender digitiform tentacles 1.7 mm. long, each of which bears one or two pinnules on each side of the middle line (see Fig. 11). In these and other similar buds from the three areas mentioned above, the tentacles are only about one-fourth of the total length of the polyp and bear few pinnules, whereas in buds of similar size present round the edge of the summit of the stem the tentacles are about one-half the total length of the polyp and bear a larger number of pinnules. (See Figs. 10 and 11; the tentacles of the two young polyps represented are equal in length.)

Few spicules are present in the stem except at the base, where they are numerous and stand almost in contact with each other. The presence of many spicules in this region gives additional strength and rigidity to the basal portion by which the colony is attached to the rock. Spicules are moderately numerous in the body of the polyp, becoming more numerous towards its distal end. They are abundant on the outer faces of the tentacles and pinnules, being close together in the latter. They are less

numerous on the inner faces of the tentacles and pinnules. By reflected light the spicules are whitish or very slightly yellow. By transmitted light some of the spicules are almost colourless but the majority have a moderately strong reddish-brown colour. The spicules are oval discs .016 mm.—.018 mm. in length and .01 mm.—.014 mm. broad.

The greater part of the colony is yellow in colour, but those parts which have been closely pressed together and partly protected from the action of the spirit are reddish-brown in colour. The label on the bottle indicates that this brown colour predominated in life.

Ova are present in considerable numbers on the edges of the ventral and lateral mesenteries of many of the larger coelentera. The largest ova, which are somewhat oval in shape, are .5 mm. \times .6 mm. in diameter (Fig. 13). These are probably mature ova. The spherical or oval nucleus is .05 mm. to .07 mm. in diameter and the exceedingly fine and close network which it contains stains deeply with haematoxylin, safranin, &c. In each nucleus there are about 15 to 20 spherical very deeply staining bodies about 6μ in diameter, and a larger number of similar but much smaller bodies about 1μ in diameter. The nucleus is situated near the edge or circumference of the ovum. A germinal spot is not present in large ova but is very well marked in young ova until they attain a diameter of about .12 mm. In ova of this size and in younger ones the germinal vesicle and germinal spot are quite typical, but in ova greater than .12 mm. in diameter the germinal spot is either very indistinct or quite absent and the nucleus has assumed the appearance and structure of the nucleus of the ripe ovum described above. The protoplasm of the peripheral part of the ovum is finely granular and devoid of yolk granules, which are however present in large quantity in the central part of the ovum. In sections of preserved ova, the yolk substance of which has been dissolved out, the protoplasm of the inner portion contains numerous more or less spherical cavities which in life contained the yolk spherules. This portion of the ovum presents a reticulate appearance as shown in the figure (Fig. 13), the protoplasmic strands are granular but the granules are not very obvious except in the peripheral portion of the inner or yolk-containing protoplasm, where there are several small but deeply staining granules. The surface of the ovum is depressed in the region of the germinal vesicle. These ova are rather larger than those of *Alcyonium digitatum* but in other respects resemble them closely (cf. Hickson, 1895, p. 377, and Figs. 40, 41).

The stomodaeum of the fully developed polyps is 1.7 mm. to 2.0 mm. in length.

Habitat. Found at a depth of two or three fathoms in Blanche Bay. New Britain.

On first examining these colonies they appeared to belong to none of the hitherto described species of *Xenia*. On comparing their chief characters with those of other species it was found that they were most nearly allied to *X. umbellata*, Savigny. The general appearance of the colony, the proportionate measurements and shape of the parts of the polyps, the long slender pinnules—all agree with Klunzinger's description of *X. umbellata* (1877, p. 39). There are however some differences which are mentioned and considered below—

(1) The polyps are slightly larger than those of Klunzinger's specimen, but the proportion of length to width is practically identical in both.

(2) The tentacles of these specimens are 5 mm.—8 mm. long, while those of Klunzinger's specimen are only 3 mm.—5 mm. in length, but Dana states that "in Savigny's figure the tentacles are a third of an inch long" (1848, p. 604), *i.e.* 8 mm. The tentacles of Dr Willey's specimens agree very closely with the latter diagnosis.

(3) There is a larger number (22—29) of pinnules in these specimens than in Klunzinger's specimen (12—15), but this is readily explained when the greater length of the tentacles of the former is considered. As shown in *X. Hicksoni* (1899, pp. 283, 284) there is a gradual and moderately constant proportional increase in the number of pinnules as the tentacles grow in length, and the proportion which holds between the length of the tentacles and the number of pinnules is almost identical in the two specimens under consideration. As shown above the larger polyps of Dr Willey's specimens contain ripe ova, and therefore the polyps are sexually mature and have probably reached their full size. There is no record of the maturity or otherwise of Klunzinger's specimen, and it is possible that the polyps which he measured had not attained their full size, which would account for the differences between his specimen and those of Savigny in the size of the tentacles and in the number of their pinnules.

4. Klunzinger's figure (1877, Tafel III. fig. 3 a) which shows a broad area free from pinnules on the inner face of the tentacle does not agree with other diagnoses of the species *X. umbellata*, *e.g.* cf. Dana, p. 605. "The papillae in the upper view of the tentacle are separated by an extremely narrow line so that those of the two sides almost meet at the base." The tentacles of the specimens from New Britain agree with the latter description very closely.

5. The stems are thicker and the whole colony has a rather stouter appearance than most specimens of *X. umbellata*, but this may be due to the influence of different external conditions and it is certainly not a sufficient reason for separating this species from *X. umbellata*.

It may therefore be concluded that although the specimens differ slightly from Klunzinger's description there is no *essential* point of difference between them and *X. umbellata*. The variations may all be accounted for by differences in age and habitat.

Previously recorded from the Red Sea, where it is abundant in the shallow waters of the coral reefs, growing on rocks or old coral branches.

XENIA VIRIDIS. SCHENK.

This species is represented in the collection by a portion of a colony, which consists of a single unbranched stem nearly half of which has been cut or torn away longitudinally. The stem is very thick, soft and fleshy, and of nearly uniform diameter along its whole length. It is 18 mm. long and 22 mm. wide at the free end. The surface of the stem is almost smooth, but near the distal end slight longitudinal ridges mark the position of the outermost or peripheral coelentera of the polyps. The summit of the stem is almost flat or only slightly convex.

The polyps are short and stout and moderately numerous. They are 4 mm.—6 mm. long and 1.5 mm.—2 mm. broad, (a very stout polyp measures 2.5 mm. in diameter). The tentacles also are short and thick, they are 4 mm.—6 mm. in length and 1 mm.—

1.5 mm. in breadth. The pinnules on the tentacle are beautifully and regularly arranged in three rows on each side of the middle line of the tentacle. Each row contains 15—20 pinnules. Those near the base of the tentacle, the first four or six transverse rows, are short rounded elevations or "warts" (Schenk) about .2 mm.—.3 mm. in length and .15 mm.—.2 mm. in breadth, but the more distal ones are conical, thick, somewhat pointed pinnules .5 mm.—.7 mm. long and .2 mm.—.25 mm. in diameter at their thickest part. The middle line of the inner face of the tentacle is free from pinnules in the proximal three-fourths of its length. The outer face of the tentacle is markedly convex.

Round the edge of the polyp-bearing summit of the stem and also on other portions of the summit between the bases of the larger polyps, young polyps in various stages of development may be found. They are more numerous on the edge of the summit. Most of them already show pinnules upon their tentacles, but those polyps the total length of which does not exceed 1.3 mm. (of which the tentacles form about .5 mm.) do not yet show pinnules upon their tentacles.

The spicules are disc-shaped and numerous. They are generally oval in shape, .018 mm.—.02 mm. in length, about .015 mm. in breadth and .006 mm. in thickness. They are whitish by reflected light and yellowish or yellowish-brown by transmitted light. Spicules are moderately numerous in the stem, there are rather more in the body of the polyp and still more on the outer face of the tentacles and pinnules. Spicules are less numerous on the inner than on the outer face of the tentacles and pinnules.

The stem is greyish green in colour and the polyps a much lighter shade of the same colour. The tentacles are almost white but have the slightest tinge of brown.

Sperm sacs are present though not in very large numbers on the edges of the ventral and lateral mesenteries of the larger polyps. The youngest sperm sacs form small spherical projections at the side or free edge of the mesentery, each of which consists of a follicle of endoderm cells within which is a thin lamina of mesogloea enclosing the genital cell or the cells which have been produced by its division (see Pl. LIII. Fig. 14). The largest sperm sacs are .25 mm. in diameter and the spermatozoa which they contain, though in an advanced stage of development, are not ripe.

On carefully examining the mesenteries in sections, many of them are seen to bear young ova, each of which is enclosed in an oval or pear-shaped follicle, in addition to the sperm sacs. (See Fig. 14.) Each ovum has rather deeply staining, somewhat granular protoplasm, scattered through which are several small cavities which, in life, probably contained the yolk granules of the ovum. The nucleus is large, clear and vesicular, about .015 mm. in diameter, and contains a well-marked, spherical, deeply staining nucleolus. These young ova are generally from .03 mm. to .05 mm. in diameter but one or two attain a diameter of .08 mm. This colony is therefore hermaphrodite, but it is evident that the male products will ripen first as they are in a much more advanced stage of development than the ova.

The stomodaeum of the larger polyps is 2.1 mm.—2.2 mm. long. The goblet-like cells to which reference has been made above may be seen among the ordinary columnar cells in the ventral and lateral regions of the stomodaeum, especially near its inner end. The siphonoglyph extends along the inner third (*i.e.* .7 mm.—.8 mm.) of its length.

Habitat. Isle du Phare Reef, Noumea, New Caledonia.

This specimen certainly belongs to the species *X. viridis*, Schenk. Even the more unimportant diagnostic characters of Schenk's species may be recognised in this specimen, *e.g.* the strongly convex outer face of the tentacle, the thick soft stem, rich in coenenchym, and the cup shape of the distal end of some of the polyps.

Previously recorded from Ternate (Moluccas).

NEW SPECIES.

XENIA NOVAE BRITANNIAE, sp. nov.

There are eight specimens referable to this species, all of which are very similar in shape, being dome-like or knob-shaped. The stem of the colony is usually single and unbranched, but each of the two colonies from Lifu, marked III. and DII. (see table of measurements on p. 519), consists of two almost equal stems connected at their bases by a thin flat band or membrane. The stem of the largest colony is 18 mm. high, 25 mm. \times 15 mm. at the base and 30 mm. \times 25 mm. at the summit. The smallest colony is about 5 mm. high and 8 mm. broad.

The polyps of all the specimens are small and resemble each other very closely in the measurements of their various parts. The measurements of the fully-developed polyps are:—body of the polyp 2.8 mm.—4.5 mm. long (a very few reach 5 mm. in length) and .8 mm.—1.3 mm. broad; tentacles 1.8 mm.—3.5 mm. long and .7 mm.—.8 mm. (occasionally 1.0 mm.) broad. Each tentacle bears three rows of short pinnules on each side of the middle line. There are 8—12 pinnules in each row. The pinnules at the proximal end of the tentacle are much shorter than the more distal ones. Seen from the outer aspect the proximal three or four pinnules are small wart-like protuberances .17 mm.—.2 mm. long and .12 mm.—.18 mm. in diameter, while the more distal ones are longer and more typical pinnules .2 mm.—.35 mm. in length and .15 mm.—.2 mm. in diameter. They are largest in the middle of the tentacle and decrease slightly in size towards its tip (see Plate LII. Fig. 2). Seen from the inner aspect the pinnules are wart-like or club-shaped outgrowths standing almost at right angles to the face of the tentacle (see Fig. 3). On the inner face of the proximal half of the tentacle there is in the middle line a narrow area free from pinnules, but nearer the tip of the tentacle the pinnules stand quite close together and many of them are flattened, on one or more of their faces, by mutual pressure.

In all the specimens buds occur apparently only on the edge of the summit of the stem. These buds are similar throughout all the colonies. The smallest bud found is .6 mm. long and its tentacles are simple rounded lobes .25 mm. long. A specimen 1.1 mm. long has simple but rather finger-shaped tentacles .4 mm. long. In a young polyp 1.2 mm. long each of the tentacles is .5 mm. in length and bears a small pinnule on each side of the middle line. In a rather older polyp 1.7 mm. in length each of the tentacles is .8 mm. long and bears two pinnules on each side.

Spicules are abundant. They are generally oval discs measuring .2 mm.—.22 mm. along their greater diameter, .015 mm.—.018 mm. along their smaller diameter and

·004 mm. in thickness. They are white or slightly bluish-white by reflected light but light reddish-brown by transmitted light. There are comparatively few spicules in the stem but they are more numerous in the body of the polyp, especially towards its distal end around the bases of the tentacles. They are abundant in the tentacles and very numerous on the outer face of the pinnules, where they are almost in contact with each other. (See Figs. 5 and 6.)

All the stems of the specimens are a very pale yellowish-green colour, but the polyps are whitish with a pale bluish bloom, due to the very numerous spicules which they contain.

Three of the colonies have been examined for sexual products and all proved to be males. On the mesenteries of many of the larger polyps sperm sacs are present in considerable numbers, in some cases they are so numerous that they almost fill up the cavity of the coelenteron in which they are contained. The largest sperm sacs are about ·32 mm. in diameter and contain almost ripe spermatozoa. (The ripe sperm sacs of *X. Hicksoni* measure ·35 mm. in diameter.) The sperm sacs are found only in those portions of the coelentera contained in the upper 5 mm. of the stem. (See Fig. 7.) From each of the colonies two or three of the largest polyps were removed, stained and cleared. The stomodaeum is very uniform in length throughout. Its length averages as nearly as possible 1 mm. In some of the smaller polyps (the body of which is only about 3 mm. long) the stomodaeum is ·8 mm. long, while in the largest polyps (the body of which is about 5 mm. long) it is about 1·2 mm. in length. In one of the most favourable specimens, cells very similar to the goblet cells to which reference has been made above may be seen in the ventral and lateral walls of the stomodaeum.

Appended are the details of the various colonies:—

Colony	Height of stem of colony	Measurements at base of stem	Measurements at summit of stem
Talili Bay I.	mm. 16	mm. 20 × 11	mm. 25 × 11
„ II.	9	10 × 10	12 × 9
„ III.	5	8 × 5	8 × 6
Lifu A.	18	20 × 17	25 × 15
„ B.	18	25 × 15	30 × 25
„ C.	25	16 × 13	22 × 20
„ D. I.	22—23	17—18	17—18
„ D. II.	8—9	18 × 13	18 × 13

The colonies from Talili Bay have a very convex polyp-bearing surface. Their polyps are slightly smaller than those of the specimens from Lifu, the bodies of the

fully developed ones being 2·8 mm.—3·3 mm. long and ·8 mm.—1·1 mm. in diameter, and their tentacles 1·8 mm.—2·1 mm. long and about ·8 mm. wide.

The colonies from Lifu are all very similar, being knob-like or dome-shaped colonies, though one or two, *e.g.* B and D II. are rather flattened from above downwards, and hence the polyp-bearing summit of the stem in these examples is rather less convex than in the others. The fully-developed polyps of all these are moderately uniform in size and character. Their measurements are:—body of polyp 3 mm.—5 mm. long and ·8 mm.—1·3 mm. broad, tentacles 2·2 mm.—3·5 mm. long and ·7 mm.—·8 mm. (occasionally 1·0 mm.) wide.

The colony from Lifu marked D I. consists of two similar and almost equal dome-shaped stems, the measurements of which are given in the above table (p. 519). The stems are bound together at their bases by a thin membrane.

Two rather irregular and flattened stems joined together at their bases by a slender connection form the colony marked D II. In this colony also the two stems are almost equal and the measurements given in the table apply to both.

The largest polyps of this species are found on the colony marked D I. Several of these are 8 mm. in length (body 5 mm., tentacles 3 mm.).

These specimens do not agree with the descriptions of any of the known species of *Xenia*. They differ from most other species in their smaller polyps and short rounded pinnules, and the latter are also much fewer in number than in most of the known species. In some respects these specimens resemble *X. plicata*, Schenk, and *X. Garciae*, Bourne, but on careful examination several important distinctions are recognised. Dr Willey's specimens differ from *X. plicata*, in—

(1) Their smaller polyps, the body of which is 2·8 mm.—4·5 mm. long and ·8 mm.—1·3 mm. broad (in *X. plicata* the corresponding measurements are 4 mm.—5 mm. and 1·5 mm.—2 mm.).

(2) Their much shorter tentacles, which are only 1·8 mm.—3·5 mm. long, while those of *X. plicata* are 5 mm.—7 mm. long.

(3) The smaller number of pinnules on the tentacles, there being only 8—12 in each row while there are 18—22 in each row in *X. plicata*.

There are other differences, *e.g.* in the arrangement of the polyps on the summit of the colony, &c., but the above are the chief.

After comparing Dr Willey's specimens with Mr Bourne's figure and description of *X. Garciae*, I was still in doubt whether the two might not be identical. Mr Bourne has kindly lent to me his specimen of *X. Garciae* so that I have been able to compare the two directly. Dr Willey's specimens certainly do not belong to this species. They differ from it in—

(1) Their longer polyps, the body of which is 2·8 mm.—4·5 mm. long (the corresponding measurement in *X. Garciae* is 1·8 mm.—3 mm.).

(2) Their longer tentacles, which attain a length of 1·8 mm.—3·5 mm. while those of *X. Garciae* are not more than 2 mm. in length.

(3) Their shorter pinnules, the length of which is .2 mm.—.35 mm. compared with .35 mm.—.5 mm. in *X. Garciae*.

The pinnules of these two forms also differ in their shape and in their position on the tentacle. The pinnules of Dr Willey's specimens are not only shorter than those of *X. Garciae* but they are quite rounded at their tips, while those of the latter are almost pointed. On viewing the *outer* face of the tentacles of *X. Garciae* it is at once noticed that the pinnules which are then visible arise close together near the middle line (see Fig. 4 and 1896, Plate 12, Fig. 14). In this respect *X. Garciae* differs markedly from Dr Willey's specimens and indeed from any other species of *Xenia* hitherto described (except Bourne's specimen of *X. coerulea*, in which also the long slender pinnules on the *outer* face of the tentacles arise moderately close to the middle line).

A comparison has been made above between the specimens from this collection and the only two hitherto described species to which they may be said to have any resemblance and it is evident that although there may be certain superficial resemblances between Dr Willey's specimens and *X. plicata* and *X. Garciae* the former differ in several important characters from these and from any other hitherto described species.

It cannot be argued that these are young colonies, the polyps of which have not yet attained their adult length and the tentacles of which have not yet acquired their full number of pinnules, because even the colony from Talili Bay, the largest polyps of which are considerably smaller than those of the colonies from Lifu, contains sperm sacs which are almost, if not quite, ripe. (The diameter of these sacs is .28 mm., the diameter of the ripe sperm sacs of this species is about .32 mm.) Thus these are not small polyps which would later grow into larger ones with longer tentacles bearing more numerous and longer pinnules characteristic of some other species. They are mature and have acquired all their adult characters.

These specimens therefore belong to a new species to which I propose to give the name *Xenia Novae Britanniae* as the first specimens were obtained from Talili Bay, New Britain (in 1895).

DIAGNOSIS OF THE SPECIES *XENIA NOVAE BRITANNIAE*.

The colony is knob-shaped or dome-shaped, the polyps arise from the strongly convex upper face of the stem. The stem of the colony is usually unbranched. (See Fig. 1.)

The measurements of the fully developed polyps are:—body 2.8 mm.—4.5 mm. in length (a few reach 5 mm.) and .8 mm.—1.3 mm. in breadth, tentacles 1.8 mm.—3.5 mm. long and .7 mm.—1.0 mm. broad. Each tentacle bears three rows of short rounded pinnules on each side of the middle line. There are 8—12 pinnules in each row. The first three or four transverse rows near the base of the tentacle are small wart-like protuberances not more than .2 mm. long but the more distal ones consist of slightly longer and more typical pinnules .2 mm.—.35 mm. long and .15 mm.—.2 mm. in diameter. The pinnules are longest near the middle of the tentacle and decrease slightly in size towards its tip. (See Fig. 2.) There is usually in the middle line of the inner face of each tentacle a narrow area free from pinnules which extends from the base rather

more than half-way towards the tip of the tentacle. In the distal portion of the tentacle the bases of the pinnules of the two sides are close together in the middle line. (See Fig. 3.)

Spicules occur in considerable numbers in the body of the polyp, especially near its distal end around the bases of the tentacles. (See Fig. 6.) They are more numerous in the tentacles and they are so abundant on the outer face of the pinnules that they are practically in contact with each other. (See Fig. 5.) The spicules are discs generally oval in shape. The fully formed ones are .2mm.—.22 mm. in length, .015 mm.—.018 mm. in breadth, and .004 mm. in thickness. They are white or slightly bluish-white by reflected light but reddish-brown by transmitted light.

The stem of the colony is a pale yellowish-green colour (in spirit) but the polyps are whitish with a pale bluish "bloom," due to the very numerous spicules which they contain.

Habitat. Talili Bay, New Britain. (Specimens taken from trawl, 1895.)

Lifu, Loyalty Islands. (November, 1896.)

HABITS, DISTRIBUTION AND CLASSIFICATION.

The *Xeniidae* have been recorded from the Red Sea and the tropical parts of the Indian and Pacific Oceans. They are not recorded from the shores of America and apparently they do not occur on the reefs near Jamaica, for although careful search has been made on these reefs no specimens of *Xenia* have been hitherto found. They are all littoral forms living in shore pools or in shallow water (3—6 fathoms), fixed to the surface of coral reefs or hanging from the under side of hollow rocks or coral boulders. They are often exposed at low water, and in those species in which the polyps are long and slender the polyps fall together into a shapeless mass on the retreat of the tide. They exhibit great variety and beauty of coloration; blue, green, brown, and yellow are the predominant colours, though two species are reddish in colour.

Several of the species of *Xenia* founded by various authors have been subsequently proved to be invalid: Lamarck's *Xenia purpurea* is certainly not a true *Xenia* but is probably a *Spongodes*: Schweigger's *Xenia esperi* and Sars' *Xenia indivisa* from Naples do not belong to the genus *Xenia*. Duchassaing and Michelotti described *Xenia carybeorum* and *X. capitata* from the West Indies, but these also are not members of the genus *Xenia*, as they differ completely in their general characters and in their spicules. The former has been renamed *Erythropodium carybeorum* by Kölliker.

The descriptions of several undoubted species of *Xenia* which have been given are not sufficiently detailed to enable these species to be again recognised and for all practical purposes they must be set aside, at least for the present. Such are the descriptions of *Cornularia multipinnata* (which is probably a true *Xenia*) by Quoy and Gaimard, *X. samoensis*, Kölliker, *X. ochracea*, Sav. Kent, *X. brunnea*, Sav. Kent, and *X. pulsitans*, Sav. Kent.

I have added a table of measurements and of the chief characters used in the diagnosis of all the other known species of *Xenia* in the hope that it may be useful to those who may work over the family in the future. Following Schenk the family may be divided into three portions.

I. The tentacles of the polyps of the species forming this division bear more or less elongated conical pinnules generally placed in two series of three rows in each. Most species of *Xenia* belong to this division. (10 species.)

II. Each tentacle bears two types of pinnules, (1) smaller short round pinnules or "warts" (Schenk) at the base of the tentacle, and (2) more typical elongated pinnules on the more distal portion of the tentacle. (4 species.)

III. The pinnules upon the tentacles are *all* small conical or rounded warts arranged either in irregular rows or scattered over the whole face of the tentacle. (2 species.)

The numbers enclosed within parentheses in the table have been added by me to the authors' descriptions, being taken either from the published figures or in the cases of *X. Garciae* and *X. coerulea* from the original specimens kindly lent to me by Mr G. C. Bourne.

GENERAL INTERNAL ANATOMY.

Sections of the stem of each, and the polyps of some, of the species above described have been cut and examined. As all the species agree moderately closely with *X. Hicksoni* (Ashworth, 1899) in the main features of their anatomy this portion of the report will be somewhat brief.

Stomodaeum and Mesenterial Filaments.

In many of the polyps the mouth is situated at the bottom of a slight depression .2 mm.—.4 mm. in depth, which has been produced by partial contraction of the oral disc. The mouth leads into the stomodaeum, which is generally compressed laterally, though in one species (*X. viridis*) it is almost circular in transverse section. The stomodaeum of the fully developed polyps varies in length from .8 mm.—2.2 mm. in the various species. The length of the stomodaeum is doubtless related in some degree to the length of the free portion of the polyp as in those species which possess short polyps, *e.g.* *X. crassa* and *X. Novae Britanniae*, in which the bodies of the polyps are only about 3 mm. in length, the stomodaeum is only .8 mm.—.9 mm. long. The length of the stomodaeum does not however appear to entirely depend on the length of the polyp, as in *X. viridis*, in which the polyps are comparatively short (the body measures 4 mm.—6 mm.), the stomodaeum is 2.1 mm.—2.2 mm. long, while in *X. membranacea* in polyps the bodies of which are 10 mm.—11 mm. long the stomodaeum is only 1.7 mm.—1.9 mm. long.

In the stomodaeum of the polyps of *X. viridis* and *X. Novae Britanniae*, the only two species from this collection which have been cut into thin transverse sections, a ventral groove or siphonoglyph is present, the cells of the lower third or two-fifths of which bear flagella.

Species	Body of Polyp		Tentacles		Pinnules				Colour	Habitat	Author
	Length mm.	Width mm.	Length mm.	Width mm.	Size mm.	Shape	No. of rows	No. of p. in each row			
<i>X. umbellata</i> , Klunzinger's description	10	1-2	3-5		.5-1	Slender, conical, pointed.	3-4 on each side	12-15	Light greyish-white to greyish-blue or yellowish. Inner side of tentacle rust brown.	Red Sea	Ehrenberg Klunzinger
<i>X. umbellata</i> , Dr Willey's specimen	5-10 or even 13	1.2-1.8	5-8	1.3-1.6	.5-.8 × 1-1.2	Long, slender.	3 each side	22-29	Reddish-brown.	Blanche Bay, New Britain Red Sea	Ashworth
<i>X. fuscescens</i> ¹		.5-1				Long, slender.	2-3 each side		In fresh state bluish-white or greyish-red. In spirit bluish or yellow grey to white.	Red Sea	Klunzinger
<i>X. coerulescens</i> , Klunzinger's description	2-5	.8-1	2.7 (3-4)	(.4-.6)	.4 (.6) × .1	Slender, filiform.	3 each side	(18-20)		Diego Garcia, Indian Ocean	Bourne
<i>X. coerulescens</i> , Bourne's description	(8-12)	(1.5-2)	(6-8)	(2-2.5)	(.6 × .2-.3)	Short, blunt.	(3 each side)	(22-25)	Stem and tentacles bluish, body of polyps brown.	Fiji Islapds	Dana
<i>X. florida</i>	(18-20 or even 30)	(2)	(5-7)	(2)	(about .5 × .1)	Slender, pointed.	3-4 each side	20-24	body of polyps bluish.	Amboyne	Dana
<i>X. elongata</i>	4-5	2-3.5	4-5	1-1.5	(about .8 × .15-.2)	Thick, conical.	3 each side	15-18	Stem and polyps grey brown, except tentacles which are yellowish.	Ternate	Schenk
<i>X. crassa</i> , Dr Willey's specimen (probably young)	3	1.5-2 (2.5)	2.5-3.2	.7-1.2	.5-.7 × .2	Short, conical.	3 each side	9-12	Stem and polyps light yellow, tentacles whitish.	Noumea	Ashworth
<i>X. fusca</i>	5-10	1.5	2.5-3	.7-1	.5	Short, conical.	6-7	13-14	Dark brown, tentacles lighter.	Ternate	Schenk
<i>X. membranacea</i>	4-6	.7-1 or 1.5	(about 4)		(.4-.5 × .1-.15)	Conical, slender.	3-4 each side	20-25	Dark yellow.	Ternate	Schenk
{ Dr Willey's specimen	5-10	.8-1.2	4.5-7	.4-.8	.5-.6 × .1	Long, thin.	6	16-18 (24)	Brown.	New Britain	Ashworth
<i>X. Hicksoni</i>	4-7	1-1.2	2-5.7	.75	.5 × .15-.2	Conical, thick.	3 each side	12-20	Brown.	Celebes	Ashworth
<i>X. Garciae</i>	3	.9	2	(.8)	.35-.5 × (.15)-.2	Short, stout.	(6)	(9-10)	Lilac coloured.	Diego Garcia, Indian Ocean	Bourne
{ <i>X. viridis</i>	4-7	1-2	4-6	1		Warts and small thick pinnules.	3 each side	14-15	Grey green.	Ternate	Schenk
{ Dr Willey's specimen	4-6	1.5-2	4-6	1-1.5		"	3 each side	15-20	Grey green, polyps lighter.	Noumea	Ashworth
<i>X. ternatana</i>	4-7	.5-1	3.5-4.5	(1-1.3)		Warts and slender pinnules.	2 each side	18-22	Stem dark grey, polyps light grey.	Ternate	Schenk
<i>X. blumi</i>	4-7	1-1.5	4-5	1		Warts and long pinnules.	3 each side	18-20	Stem dark grey, polyps light grey.	Ternate	Schenk
<i>X. Novae Britanniae</i>	2.8-4.5 or even 5	.8-1.3	1.8-3.5	.7-.8 or even 1.0	not more than .35	Short, rounded.	3 each side	8-12	Stem pale yellowish-green, polyps nearly white.	Talili Bay, New Britain, and Lifu	Ashworth
<i>X. plicata</i>	4-5	1.5-2	5-7	.5-1		Short round warts.	3 each side	18-22	Stem dark grey, polyps light grey.	Ternate	Schenk
<i>X. rubens</i>	6-11	1.5-3	3-4	.5-1		Very short warts.	5-6 irregular	18-20	Stem reddish, polyps greyish-yellow.	Ternate	Schenk
<i>Heteractenia Elizabethae</i> , Kölliker's description, Polyps	20-40	2.5-3	up to 15			Long, slender.	4 (?) each side	—	—	Port Denison	Kölliker
" Zooids	3-5	.7-1	.14-.2			None.	—	—	—		
Another specimen, Polyps	10-25	1-2	4-5		.5 × .1	Slender pinnules.	3 each	16-24	Whitish (in spirit).	Zanzibar	Ashworth
" Zooids	2-5	.5-1	.2-.25			None.	—	—	—		

¹ Measurements and colour same as *X. umbellata*, according to Klunzinger. It differs in possessing numerous zooids 1-2 mm. long and ½ mm. wide, which have simple tentacles.

In the same sections, among the ordinary columnar cells which line the greater part of the stomodaeum, there are swollen and apparently empty cells similar in appearance and position to those described in *X. Hicksoni* (1899, p. 251). They are cells which have been swollen by some secretion to which they give rise, and, having discharged this secretion, now appear empty. The stomodaeum of the stained polyps of *X. crassa* also shows, when the walls are seen by transparency, numerous small light areas, which probably indicate the presence of these secretory cells. The polyps of *X. umbellata* and *X. membranacea* are not sufficiently well preserved to show this point in their structure.

In all the species the polyps are devoid of ventral and lateral mesenterial filaments but the dorsal mesenterial filaments are present and well developed. They run in a sinuous course down the dorsal side of the coelenteron and in the primary polyps extend to the base of the colony. (See Fig. 7.) They agree in structure with those of *X. Hicksoni*.

Coelentera of Polyps.

The eight mesenteries are arranged as in typical *Alcyonaria*. The mesenteries of all the species in the collection are very thin, much thinner than those of *X. Hicksoni*, and their retractor muscles are feebly developed, forming only a very slight ridge on the ventral face of each mesentery. The small size of these muscles probably accounts for the non-retractile character of the polyps.

Between the two endodermic lamellae covering the mesentery there is a thin plate of mesogloea which is slightly thickened near the inner or free edge of the mesentery. In this portion cells are usually present similar to those found in a corresponding position in the mesenteries of *X. Hicksoni*. These are endoderm cells which have migrated into the mesogloea and give rise to the genital products. They have reticulate protoplasm and large nuclei. (See Fig. 14.)

Mesogloea, its Canals and Cells.

As in *X. Hicksoni*, there is around each coelenteron in the stem (at any rate in its upper part) a denser, more deeply staining cylinder of mesogloea which belongs to the coelenteron within it. (See Fig. 7.) This is almost free from cells but is surrounded by a cylinder of ectoderm cells in which there are numerous spicules. (1899, Pl. 25, Figs. 8, 9.) Spicules have migrated from this chain of cells into other parts of the mesogloea, in which they are more abundant than in *X. Hicksoni*.

The superficial canal system is very uniform throughout, consisting of a plexus of canals situated about .1 mm. below the ectoderm of the stem. (See Fig. 9.) The outer wall of these canals is thicker than the inner owing to the cells of the former being more columnar than those of the latter wall. The cavity of this system of canals is invaded by zooxanthellae throughout.

The internal canal system varies in the development of its parts to a considerable extent. The extreme in one direction is reached in *X. viridis*, in which the longitudinal canals which run in a sinuous course in the mesogloea about midway between the coelentera are feebly marked. As if to compensate for this the transverse canals which

connect together the coelentera and the longitudinal and superficial canals are exceedingly numerous, as also are the cords and strands of cells. In *X. crassa* and *X. Novae Britanniae* the longitudinal canals are very well marked and the transverse canals are fewer in number than in *X. viridis* but still are very numerous (Fig. 8). In all species the mesogloea (except the denser ring round each coelenteron referred to above) is traversed by numerous strands of cells which place all its parts in intimate communication. (See Fig. 8.)

In sections which pass very obliquely through the ectoderm and mesogloea of polyps of *X. viridis* small stellate cells, connected with fine fibrils which run inwards to the endoderm, may be seen. This system of fibrils and cells has been more fully described in *X. Hicksoni* (1899, p. 277), in the account of which it was suggested that these are nervous elements homologous with the similar plexus seen in the base of the ectoderm of *Alcyonium* and compared by Hickson with the "Nervenschicht" of the *Actiniae* (1895, p. 371).

Ectoderm.

In the inner or basal portions of many of the ectoderm cells of the tentacles there are muscle fibres which are longitudinal in direction. These are much more highly developed on the oral than on the aboral face. It is owing to their contraction that the tentacles of some of the specimens are somewhat curled inwards over the mouth. The ectoderm of *X. membranacea* contains numerous nematocysts which are, like those of *X. Hicksoni* and of most other *Alcyonaria*, exceedingly small (see p. 513).

The spicules are similar throughout, being round or oval discs of horny consistency (Figs. 5 and 6). On examining sections or stained preparations of the ectoderm each spicule is seen to be accompanied by the nucleus and remains of the protoplasm of the cell in which it has been formed.

Endoderm.

In none of the specimens does the protoplasm of the endoderm cells present the well-marked reticulate structure which was noticed in *X. Hicksoni*. In *X. viridis*, in which the endoderm is moderately well preserved, the cells lining the coelenteron and particularly those covering the mesenteries are long, narrow, columnar cells which have a finely granular protoplasm with few or no vacuoles.

Zooxanthellae are present in the endoderm of the body of the polyp but in comparatively small numbers; they are more numerous in the endoderm of the tentacles and pinnules, especially in the latter, where they are sometimes so abundant that they almost fill up the cavities of the pinnules.

Gonads.

Gonads are present in all the species on the edges or sides of the ventral and lateral mesenteries, and are developed from the cells which are present in the mesogloea of these mesenteries near their free edges (see p. 525 and Fig. 14). The gonads are most abundant in the portions of the coelentera contained in the upper part of each stem.

Seven colonies were examined for sexual products, five are male, one female, and one (*X. viridis*) hermaphrodite, containing young ova and more advanced spermatozoa (for more detailed description see p. 517 and Fig. 14).

The spermatozoa arise and develop similarly to those of *X. Hicksoni*. The ripe spermatozoa of *X. Novae Britanniae* are considerably smaller than those of *X. Hicksoni*. In *X. umbellata* large and probably ripe ova are present. The largest ova are somewhat oval in shape and .5 mm. \times .6 mm. in diameter. These ova are described in detail on p. 515. They are rather larger than those of *Alcyonium digitatum* but in other respects resemble them closely.

ADDENDUM.

Since the completion of this Report a memoir by Walther May (*Beiträge zur Systematik und Chorologie der Alcyonaceen*. Jenaische Zeitschrift. Band XXXIII. Heft 1, Jena, 1899) has come into my hands. This memoir contains a description of six new species of *Xenia* and records the taking of four other previously known species.

May (p. 77) suggests that probably *X. viridis*, Schenk, and *X. elongata*, Dana, are identical and that the descriptions of *X. plicata*, Schenk, and *X. florida*, Dana, do not mention any characters by which the two species may be distinguished. With regard to the former statement it may be pointed out that there are several essential points of difference between *X. viridis* and *X. elongata*. The great length of the polyps of the latter, shown in Dana's figure (1848, Plate 57, Fig. 5) to be 18—20 mm. or even 30 mm. long, and their "slender and elongate" pinnules (Dana, 1848, p. 607) distinguish this species from *X. viridis*, in which the polyp bodies are only 4—7 mm. long and the pinnules are small and thick or small round warts (Schenk, 1896, p. 62). Dana's description of *X. florida* is not as detailed as we could wish and there certainly is difficulty in distinguishing this species from *X. plicata*. The bodies of the polyps of the former are of greater length, being 8—12 mm. long according to Dana's figure (1848, Plate 57, Fig. 4) while those of *X. plicata* are only 4—5 mm. long and the tentacles of the former are broader than those of the latter (see table, p. 524).

May also records *X. umbellata*, Savigny, from Mozambique, Tumbatu and Baui Island, *X. elisabethae* (= *Heteroxenia Elisabethae*), Kölliker, and *X. membranacea*, Schenk, from Zanzibar, and *X. blumi*, Schenk, from Tanga and Suez.

Six new species are described by May but there are several important points with regard to which further details would have been useful to systematists, *e.g.* the number of pinnules in the rows present on the tentacles or the number of pinnules visible on one side of the outer aspect of the tentacle of an adult polyp. The size of the pinnules is also a useful factor. Both these characters are omitted from May's diagnoses and descriptions. The new species are—*X. tumbatuana*, *X. quinqueserta* and *X. medusoides* from Tumbatu, *X. bauiana* from Zanzibar and Baui Island, *X. sansibariana* from Zanzibar and *X. rigida* from Mozambique.

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EXPLANATION OF PLATES LII. AND LIII.

LIST OF REFERENCE LETTERS.

D. M. F. Dorsal mesenterial filament. *Ect.* Ectoderm. *Ect. Ch.* Chain or cylinder of ectoderm cells surrounding the cylinder of denser mesogloea. *Ect. Str.* Strands of ectoderm cells. *End.* Endoderm. *End. Can.* Endodermic canals. *G. V.* Germinal vesicle of ovum. *Gen. C.* Genital cells in various stages of development. *Long. Can.* Longitudinal endodermic canal. *Mg.* Mesogloea. *Mg. D.* Denser cylinder of mesogloea around each coelenteron in the stem. *M. P.* Muscle processes of endoderm cells. *N.* Nucleus. *Ov.* Ovum. *Sp.* Spicule. *St.* Stomodaeum. *Sup. Can.* Superficial canal. *S. S.* Sperm sac. *V. M.* Ventral mesentery.

PLATE LII.

FIG. 1. *Xenia Novae Britanniae*. View of a colony from Lifu (A in Table, p. 519). The general shape of the colony, the soft, fleshy base and the strongly convex area from which the polyps arise may be seen. The polyps are smaller and closer together near the base of the colony. $\times 3$.

FIG. 2. *X. Novae Britanniae*. One of the largest polyps of a colony from Lifu (DI in Table, p. 519). On their outer faces the tentacles show clearly a row of pinnules on each side, the basal three or four pinnules are small, rounded and wartlike, while the more distal ones are longer and more typical pinnules. From the inner aspect three rows of pinnules are visible on each side of each tentacle. $\times 15$.

FIG. 3. *X. Novae Britanniae*. A tentacle of the polyp shown in Fig. 2, seen from the inner or oral side. Near the base of the tentacle there is a narrow area free from pinnules separating the pinnules of the two sides. The more distal pinnules are situated close together and many of them are flattened on one or more of their faces by mutual pressure. The tentacle was slightly flattened in preparation and hence appears a little broader than it would be in life. $\times 20$.

FIG. 4. *Xenia Garciae*, Bourne. One of the largest polyps of the colony, lent to me by Mr G. C. Bourne. Note that the pinnules seen on viewing the tentacles from the outer aspect arise close to the middle line, thus differing from those of the tentacles of *X. Novae Britanniae* (compare Figs. 2 and 4). The specimen has been somewhat flattened by contact with the sides of the bottle. $\times 15$.

FIG. 5. *Xenia Novae Britanniae*. Outer surface of a pinnule of a tentacle of a polyp, showing the very numerous disc-like spicules present in the ectoderm. The spicules are often in contact or even overlapping. $\times 190$.

FIG. 6. A portion of the body-wall of the same polyp 2 mm. below the bases of the tentacles. Note that the spicules are much less numerous than in the pinnules. $\times 190$.

FIG. 7. *Xenia Novae Britanniae*. A thick longitudinal section through the middle of the colony represented in Fig. 1. The strongly convex area from which the free parts of the polyps arise may be seen. The coelentera of the polyps extend a considerable distance into the stem, those of the large polyps extending to the base of the colony. On the dorsal side of each polyp one of the dorsal mesenterial filaments (*D. M. F.*) is shown and may be traced almost to the lower end of the coelenteron; on the ventral side of the polyp the thin edge of the ventral mesentery (*V. M.*) may be seen. These have been omitted for the sake of clearness from polyps I, II, III, VI. On the right the section passes through a bud or young polyp (I), the free part of which is 2 mm. long. The coelenteron of this polyp extends only a comparatively short distance into the stem. The stomodaeum (*St.*) of two polyps (IV, V) is shown. The coelentera of the older polyps (IV, V, VI, VII) are crowded with sperm sacs (*S. S.*) in the portions situated in the upper part of the stem, but they have been omitted from polyps V, VI. The superficial (*Sup. Can.*) and longitudinal (*Long. Can.*) canal systems; their relation to each other and to the coelentera of the polyps, the plexus of canals at the base of the colony and the ectoderm (represented when seen in section by a thick black line) are shown. The outer walls of the superficial canals are thicker than the inner walls. Around each coelenteron there is a denser cylinder of mesogloea (*Mg. D.*), this is shown only in polyps VI, VII, being represented by the darker tone round these coelentera. Semi-diagrammatic $\times 6$.

PLATE LIII.

FIG. 8. *Xenia Novae Britanniae*. A freehand section about .15 mm. thick passing through the column of mesogloea between two adjacent coelentera. The thick dark bands (*End.*) right and left represent the endoderm of the coelentera. The denser cylinder of mesogloea (*Mg. D.*) almost devoid of cells which encloses each coelenteron, with its surrounding ectoderm cells (*Ect. Ch.*); the numerous strands of ectoderm cells (*Ect. Str.*) passing through the other portions of the mesogloea: the longitudinal canal (*Long. Can.*) with its branches (*End. Can.*) opening into the coelentera: the superficial canal system (*Sup. Can.*) seen in section with its thicker outer walls, and its relation to the longitudinal canal system (*Long. Can.*) may be seen. $\times 70$.

FIG. 9. *Xenia Novae Britanniae*. A portion of the superficial canal system which has been stripped off the stem along with the ectoderm. The canals are nearly all in one plane forming a close network about .1 mm. beneath the ectoderm. $\times 100$.

FIG. 10. *Xenia umbellata*. A bud from the edge of the summit of one of the stems. The total length of the young polyp is 3.3 mm., the tentacles are 1.5 mm. long and show, from the outer aspect, five or six pinnules on each side of the axis of the tentacle. Viewed

from the inner side (see the tentacle on the left) two rows of pinnules are visible on each side of the middle line, a third row will be formed later. This is typical of the buds of the *Xeniidae*. $\times 15$.

FIG. 11. *X. umbellata*. A bud from the middle portion of the summit of a stem. The body of the young polyp has grown much larger in proportion to the tentacles than is usual. The total length of the polyp is 6 mm., its slender finger-like tentacles are 1.5 mm. long and bear only one or two pinnules on each side. The tentacles of this and of the specimen shown in Fig. 10 are equal in length. See also p. 514. $\times 15$.

FIG. 12. *X. umbellata*. A bud 5 mm. long from the middle portion of the summit of a stem. This is similar to, but probably younger than the one shown in Fig. 11. The body is very stout, the tentacles are somewhat unequal and measure 1.0 mm. to 1.3 mm. in length. Some of them (on the left) are trilobed at their free ends, *i.e.* there is an indication of the formation of the first two pinnules. See also p. 514. $\times 15$.

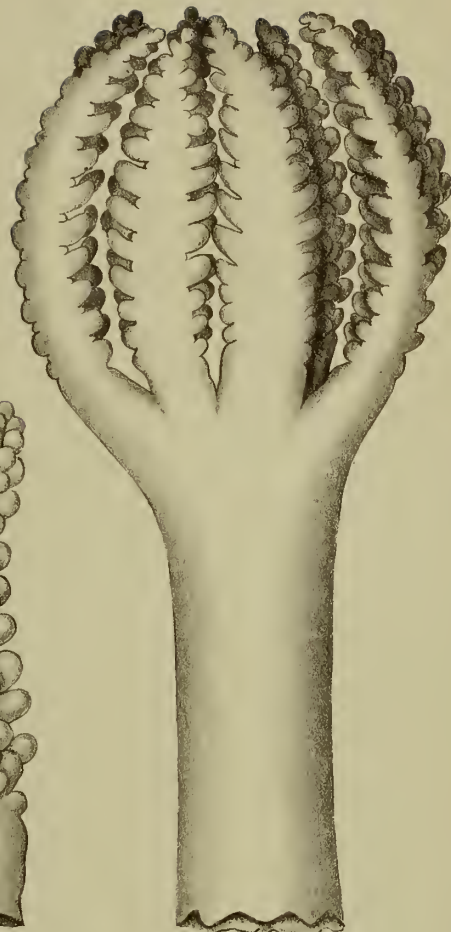
FIG. 13. *X. umbellata*. Thin section (5μ) of an ovum probably almost mature. The peripheral zone of protoplasm is finely granular and devoid of yolk spherules, the central mass of protoplasm contains many cavities, which in life probably contained the yolk spherules. For further description see p. 515. $\times 200$.

FIG. 14. *Xenia viridis*. Portion of a thin section of a mesentery which bears male and female products. On the right the mesentery is cut almost longitudinally, showing in the mesogloea (*Mg.*) the cells (*Gen. C.*) with well-marked nuclei and reticulate protoplasm which give rise to genital products. In the centre of the figure are several very young sperm sacs, each of which contains a few cells produced by division of one of the primitive genital cells. Below and on the right is a large sperm sac containing many hundreds of sexual cells which after a very few more divisions would give rise to spermatozoa. To the left of the sac is one of its genital cells more highly magnified ($\times 2000$) to show the large nucleus (*N.*). On the left of the figure are four young ova (*Ov.*) each in its follicle of endoderm (*End.*). Each has a well-marked germinal vesicle (*G. V.*) and germinal spot. The small cavities in the somewhat granular protoplasm probably contain yolk spherules in life. $\times 320$.





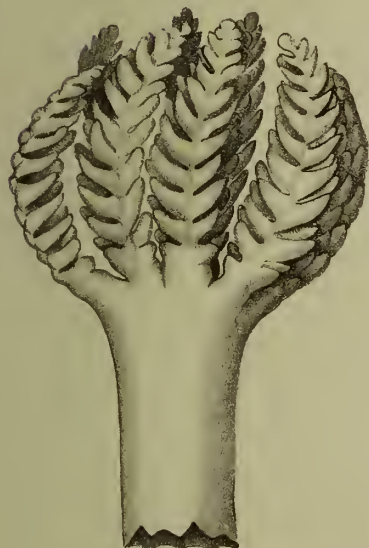
1. x 3



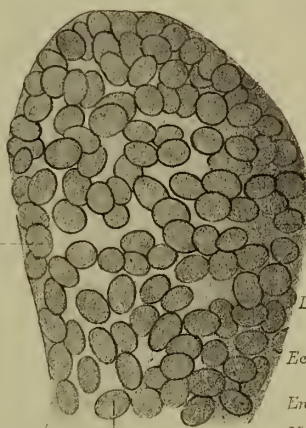
2. x 15



3. x 20



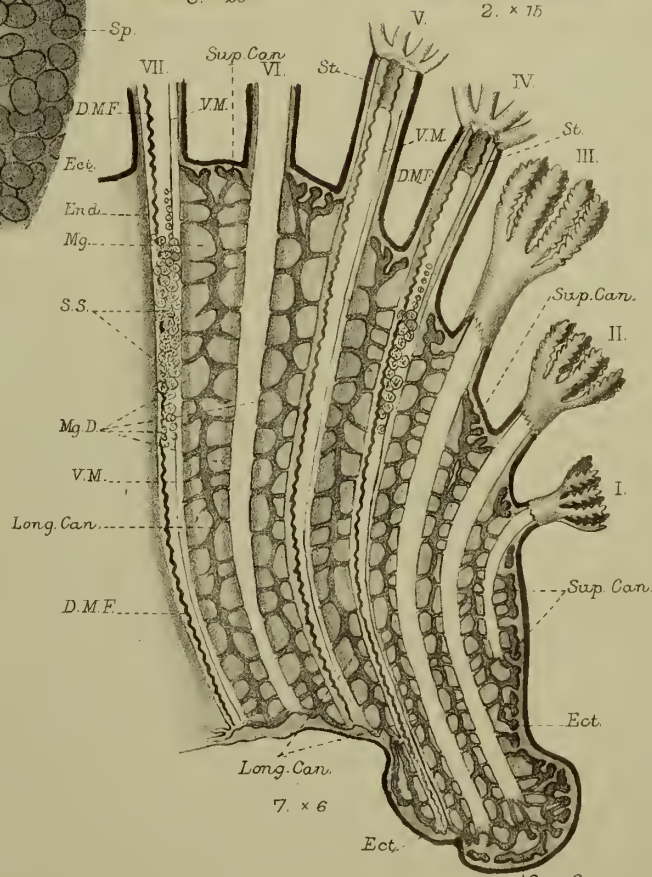
4. x 15



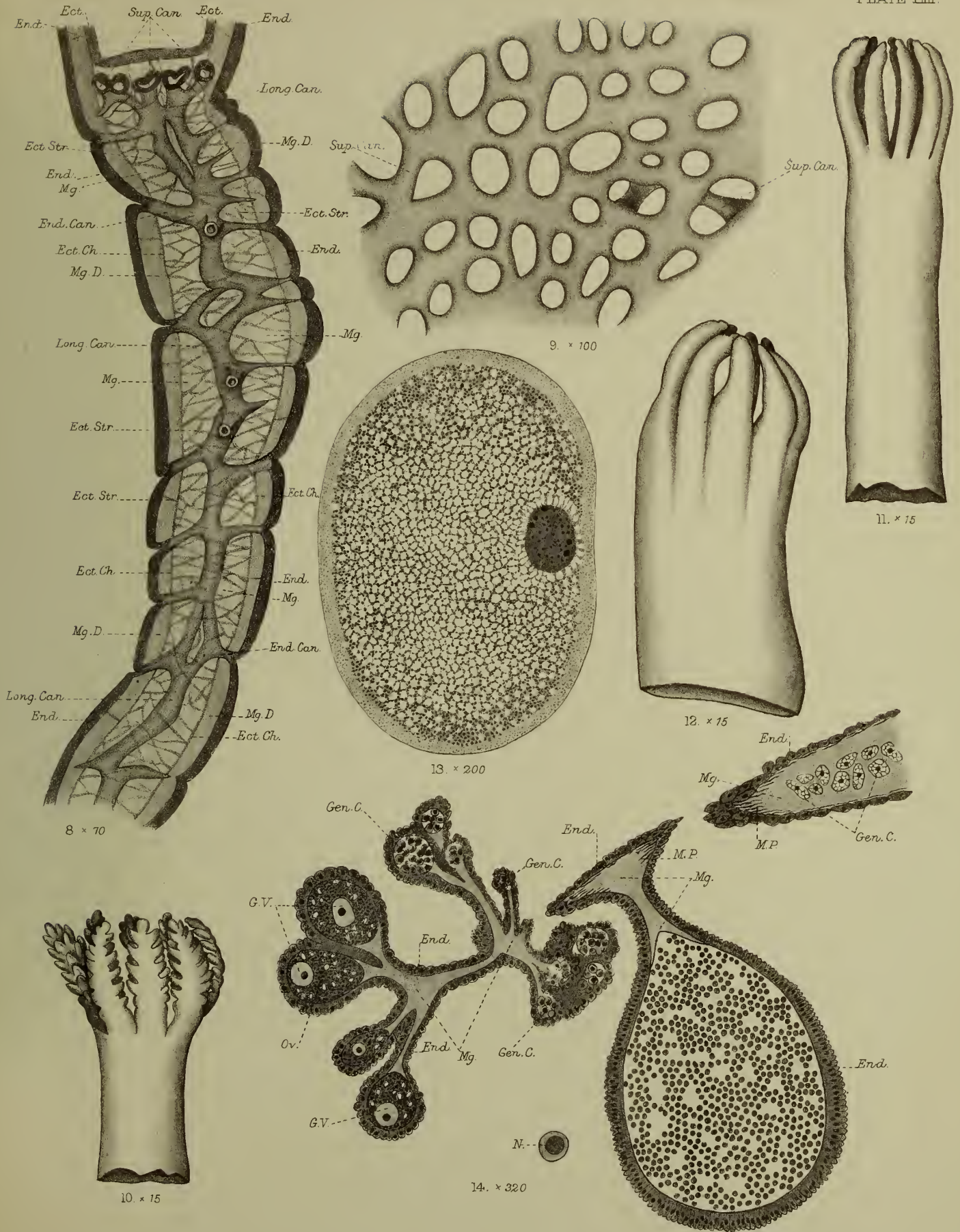
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PART V. is in the Press and will be published during the next winter.

